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GEOLOGICAL SURVEY OF CANADA.

SIR W. E. LOGAN, F.R.S., DIRECTOR.

REPORT

OF

DR. T. STERRY HUNT, F.R.S.,

ON THE

GOLD REGION OF NOVA SCOTIA.



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THE GOLD REGION OF NOVA SCOTIA.

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R E T U R N

To an Address of the House of Commons, dated 15th April, 1868 ; for Copies of Reports made by the Officers of the Geological Survey, with reference to the Gold Districts of Nova Scotia.

By Command.

HECTOR L. LANGEVIN,

Secretary of State.

DEPARTMENT OF THE SECRETARY OF STATE,

Ottawa, 5th May, 1868.

THE GOLD REGION OF NOVA SCOTIA.

REPORT

OF

DR. T. STERRY HUNT, F.R.S.,

ADDRESSED TO SIR W. E. LOGAN, LL.D., F.R.S., F.G.S., ETC., DIRECTOR OF THE
GEOLOGICAL SURVEY OF CANADA.

MONTREAL, April 30, 1868.

SIR,—Early in the month of November last you were pleased to order me to proceed to Nova Scotia for the purpose of making some observations on the gold-bearing rocks of that Province, with the view of comparing them with those of other parts of the Dominion,* and also of obtaining such information as might be useful in the event of a Geological Survey of Nova Scotia itself. In this excursion I was accompanied by Mr. A. Michel, who had already and independently formed the plan of visiting the gold region of that Province, and of whose extensive knowledge in matters connected with gold-mining I was anxious to avail myself. My own stay in Nova Scotia was confined to about four weeks in the months of November and December, but as it seemed not improbable that a report on that region might be called for, it was deemed desirable to secure the services of Mr. Michel during another month, which he spent in the Province after my return. A report drawn up by him is before me, and will be made use of in the following pages.

*NOTE.—In this connection may be noticed the recent announcement by Prof. E. J. Chapman, of University College, Toronto, in a letter dated March 8, 1868, and published in the *Toronto Globe and Leader*. He has found gold in certain specimens of copper pyrites and galena, collected by himself from veins in the region of Black Bay, lying between Neepigon River and Thunder Bay, on Lake Superior. Carefully repeated assays by him of these ores yielded amounts of gold varying from 17 dwt. to 19 dwt., together with rather more than 2 oz. of silver to the ton. Some of the ores contained, besides, from eight to eleven per cent of copper, and one nearly one-half of its weight of lead.

These veins, as remarked by Prof. Chapman, belong to the Upper Copper-bearing rocks of Lake Superior, described as altered Silurian strata in the *Geology of Canada*, chapter V. By referring to that work, on page 76, where the veins of this series of rocks are described, it will be seen that the presence of small quantities of gold in one them, associated with silver, copper, and cobalt, is indicated. I detected gold with the silver from Prince's Mine, in 1848, as described in the Geological Report of that year, page 63, and in 1863, wrote as follows in the *Geology of Canada*, page 745:—

“It has already been mentioned that the native silver from Prince's Mine contains small quantities of gold. The parallelism in age and mineral contents between the Upper Copper-bearing rocks of Lake Superior and the Quebec group of Eastern Canada, makes it not improbable that gold may one day be added to the list of the mineral riches of Lake Superior.”

This anticipation, however, in no way detracts from the economic importance of Prof. Chapman's discovery.

GEOLOGY OF THE GOLD REGION.

The principal sources of information about the geology and mineralogy of the Nova Scotia gold region are as follows: Dr. J. W. Dawson's *Acadian Geology*, published in 1855; a report of Mr. Henry Poole, dated January 31st, 1862; one by Mr. John Campbell, dated February 25th, of the same year, and a second, dated February, 1863, and accompanied with a geological section. These reports were published by the Provincial Government. In addition to these should be noticed the valuable reports of Prof. Benjamin Silliman, published in 1864; one on the Tangier district, and another on those of Waverley and Montague. To each of these is prefixed a sketch of the gold region, embodying a great amount of information with regard to its geology, mineralogy and economic importance. In the following introductory pages I shall make free use of the data furnished by the gentlemen just named, adding thereto such observations as I was able to make during my own short visit at a season of the year very unfavorable to examination. Farther researches will doubtless enable us to extend and, perhaps, to modify, in some particulars, the statements here made with regard to the geology of the region, which still presents many points requiring farther study. I must here call attention to a little work published within the last three months by Mr. John Lovell of this city, and entitled *A Practical Guide to the Gold Fields of Nova Scotia*, by Mr. Heatherington, now of Halifax. In it the author has brought together a great mass of information with regard to the history and present prospects of the gold region of Nova Scotia, together with important statistical tables, and an Appendix containing, among other things, the text of the present mining laws of Nova Scotia. He has also given copious extracts from the reports of Messrs. Poole and Campbell, together with a reduced copy of the geological section appended by the latter to his report of 1863. Mr. Heatherington commenced the publication, in January last, of a monthly journal called the *Mining Gazette*, and devoted to the mining interests of Nova Scotia.

Although the *Acadian Geology* of Dr. Dawson was published in 1855,* some years before the discovery of gold, there will be found in its fifteenth chapter a somewhat detailed description of the coast district of Nova Scotia, which has since become famous as a gold region. This consists of a zone of ancient stratified rocks lying exposed between the overlying strata of the Carboniferous system on the north-west and the ocean on the south-east, and having a breadth of from thirty to fifty miles in the wider portions, which to the north-east is reduced to not over eight miles. This belt of rocks extends along the Atlantic coast for a distance of about 250 miles, from Cape Sable on the west to Cape Cansau on the east, and has a superficies of about 6,000 square miles. Its surface is generally low, rising, however, in some places, to about 500 feet above the sea, and is in great part rocky and barren, the powerful denuding agencies to which, in past times, it has been exposed, having, over a large portion of the area, removed the alluvial deposits with which it was once covered and left the upturned and worn edges of the strata bare, or covered only with boulders of quartzite or granitic rocks. A large portion of this region is still an unexplored wilderness, and some of the most important gold districts are in localities which, until the discovery of the precious metal, were unclaimed forests, so that it is in every way probable

* A second and much enlarged edition of this work is now in press, and will shortly appear.

that farther explorations may detect many other districts not less important than those already known.

The rocks of this region consist chiefly of slates and quartzites; they are, however, cut in many places by intrusive granites, and in addition to these several small areas of gneissic rocks occur in different parts of the belt, but their true relations to the great mass of the strata are not yet clearly made out. Leaving these aside, the rocks which cover the principal part of the area under consideration, are, by Mr. Campbell, divided into a quartzite group, and a clay-slate group, the latter conformably overlying the quartzite, and the two constituting one gold-bearing series; the total measured thickness of these two divisions is, according to the same authority, nearly two miles; but the gold appears to be chiefly confined to the quartzite, and the lower portions of the clay slate division. The geological age of these rocks is uncertain; although comparatively little altered, they are without fossils, so far as yet known, and are very unlike the fossiliferous Upper Silurian and Devonian rocks met with in other parts of the Province; at the same time the high antiquity of the gold-bearing strata is shown by the fact that the Carboniferous system rests upon their upturned edges, and is partly formed from their ruins. In the present state of our knowledge it appears probable that they may represent a part of the Lower Silurian series, which, like the Upper Silurian and Devonian of this part of the continent, may be supposed to consist chiefly of non-calcareous sediments.

The rocks of the gold series are affected by undulations running nearly east and west, which have raised the strata to high angles, often approaching the vertical. According to Mr. Campbell there are not less than six principal anticlinalis exhibited on a transverse line of section, extending from the sea shore at the southeast entrance to Halifax Harbor, northward to the Renfrew gold district, a distance of about thirty-five miles. The direction of these nearly parallel anticlinalis is about east and west; but to the westward they bend towards the south, and to the eastward, in like manner, disappear beneath the sea, between Cape Canseau and Liscombe Harbor, with a strike, E. 30° S.

In addition to the great east and west folds, the gold series is affected by a second series of more gentle undulations, having a north and south direction, and producing transverse anticlinalis, on the crowns of which the gold-bearing portions of the series are brought to the surface, while they are concealed not only in the great east and west synclinalis, but also in the north and south synclinalis where these traverse the east and west anticlinalis. The total thickness of the series, as already stated, is estimated at about two miles, and the amount of erosion on the crowns of some of the anticlinalis, according to Mr. Campbell, cannot be less than one and a half miles in vertical thickness, of which the upper half mile, consisting of clay slates, is generally sterile. Since, so far as yet observed, the gold is confined to the quartzite and the lowest portions of the overlying clay slate, it would follow that wide areas of the latter, holding the upper portions of it, will be destitute of gold, or yield it only along a narrow belt where the lower and auriferous portions of the slate may be brought to the surface along the line of an anticlinal, as is observed, according to Mr. C., at the Ovens gold field. When, on the contrary, erosion has exposed a wide zone of the underlying quartzite on the crest of an anticlinal, the breadth of the area in which gold may be sought for is much increased.

Mr. Campbell has called special attention to what he has called the grain or reed-like

marking often impressed on the surface of the beds in a direction parallel to the east and west axes of folding, and he points out that the angle of dip, eastward or westward, of these markings on the crown of the great anticlinal enables us to detect the transverse or north and south lines of undulation, which have at a subsequent period disturbed the horizontality of the east and west anticlinal folds. The markings in question often appear as rib-like ridges or flutings, which are most conspicuous on the surface of the auriferous quartz layers and the enclosing beds. On the summit of the anticlinal folds they are sometimes so large, and so well defined as to give to the layers a wrinkled or corrugated form, producing what is designated in the region as barrel quartz, and has by some observers been compared to the ripples on water, and by others to that parallel arrangement of logs which is seen on what is called a corduroy road. The best known samples of this is at Waverley, but it is also seen at Montague, Oldham, and at Upper Stewiacke.

To return to the six east and west anticlinal recognized by Mr. Campbell in his section from the southeast entrance of Halifax Harbor to Renfrew,—the Ovens and Tangier gold-fields, according to him occur on the first or southernmost anticlinal, while that of Lawrencetown is on the second, Old Tangier on the third, Waverley on the fourth, Oldham on the fifth, and Renfrew on the sixth anticlinal. Farther to the northeastward the gold fields of Wine Harbor, Sherbrooke, Isaac's Harbor and Country Harbor, are by him respectively referred to the second, third, fourth and fifth anticlinal.

Mr. Campbell has described an interesting locality to the north of the anticlinal of Country Harbor, which merits further examination, and may be mentioned in this connection. It is at the Narrows of Country Harbor, and near a range of high granitic hills, which appear on the western side of the harbor, running northward; while the general direction of the rocks in this region is N. 60° W., they have, at the locality in question, a strike of N. 15° W., and dip towards the granite at an angle of eighty-five degrees. Regularly interstratified with the beds, which are here more micaceous than farther southward, are numerous quartz lodes in a band of about 600 yards in breadth, the quartz holding gold, with mispickel and small garnets and zircons. Minute portions of oxide of tin were also, according to Mr. Campbell, found with gold in alluvial washings from this neighborhood.

Having thus acquired a general notion of the geological structure of the region, we may consider its lithological characters, which are very simple: The quartzite which forms the principal rock of the lower division, interstratified however with thin layers of bluish argillite or clay slate, is essentially a granular quartz rock, with an apparently argillaceous cement, sometimes considerable in amount. It is hard and gray in color, passing into blackish or greenish in the interior, but becoming nearly white on weathered surfaces. Its lines of bedding are distinct, and besides two sets of joints which often cause it to break into regular rhombic masses, it occasionally shows a slaty cleavage, independent of the bedding, and from a development of mica in the cleavage planes, passes into a very quartzose mica slate. The quartzite of this region is, by the miners generally designated as *whin*, the vulgar name in Scotland for a greenstone or diorite, which somewhat resembles it in color and texture, though a softer rock than the Nova Scotia quartzite.

The slate, which is interstratified in thin bands with the quartzites, and frequently forms the underlying rock of the gold-bearing quartz lodes, is generally a soft and fissile,

bluish or blackish argillite, or clay slate, and the same may be said of the strata which forms the base of the upper or clay slate division of the gold series, so far as I have have had an opportunity of observing it. A peculiarity of this region, which strikes every mineralogist, is the great rarity of everything like calcareous rocks or minerals. This is seen in the absence of limestone, serpentine, diorite or other hornblendic rocks, and of talcose or chloritic slates, nothing of the kind being met with in most of the gold districts. Prof. Silliman, however, mentions the rare occurrence of chloritic slate, and also of epidote and staurotide in minute crystals in the Tangier district, and of a green magnesian rock resembling serpentine and holding gold, at Wine Harbor. Small portions of chlorite are found in the quartz lodes at Sherbrooke, Oldham and Montague. Chloritic and hornblendic rocks, according to Dr. Dawson, occur near Yarmouth, and in the peninsula which terminates in Cape Canseau, fine-grained gneiss with much mica slate, and clay slates abounding in crystals of chiastolite, are met with.

METALLIFEROUS LODES.

In the series of rocks just described gold is occasionally met with disseminated both in the quartzite and in its accompanying bands of slate; but it is chiefly found in well-defined beds or layers of a more or less pure quartz, which are generally very distinct from these rocks, although interstratified with them. Besides these there are other quartz lodes which cut or intersect the strata, filling cross fissures, which, according to Mr. Campbell, are generally connected with the north and south lines of elevation. These cross veins are irregular, seldom continuous, and, though sometimes carrying gold, are of little economic importance and seldom wrought. The fact that the productive quartz lodes of Nova Scotia are conformable with the stratification has been insisted upon both by Messrs. Silliman and Campbell. The latter, who conceives them to be newer than the strata, and to have been formed in openings or separations between the beds of slate and quartzite, mentions that the lodes in some instances pass from the plane of one bed to another, in descending. In one supposed instance pointed out to me, this appearance seemed due to a small fault running east and west, parallel with and near the crown of a great anticlinal. In other cases this apparent change of plane depends, I think, upon irregularities in the bedding, and the intercalation of lenticular masses of argillite or quartzite in the layers of metalliferous quartz. The beds of all these materials occasionally thin out and disappear in the strike or dip, and in some cases beds of quartz separated by layers of interposed rock are found to unite, farther on, into a single bed. So far as my present observation goes, I think that to describe them otherwise than as interstratified beds would be to give a false notion of their geognostic relations. The laminated structure of many of the lodes, and the intercalation between their layers of thin continuous films or layers of argillite, can hardly be explained in any other way than by supposing these lodes to have been formed by successive deposition at what was, at the time, the surface of the earth. There is, moreover, evidence that these laminæ were formed before the lodes were folded and contorted; this is furnished by some remarkable specimens of the so-called barrel quartz which I took from a lode at Upper Stewiacke, and which consists of a bluish quartz in thin plates, sometimes not more than one-twentieth of an inch in thickness, and presenting in some instances glazed surfaces coated with thin argillaceous films, and in others, pellicles of argillite having the thickness of paper. The surfaces of all these layers are deeply

striated or furrowed at right angles to the axis of the larger convolutions of the bed, a result evidently due to a sliding of the layers of the quartz lode over one another during the corrugation of the strata which has here taken place near the summit of the anticlinal. It seems not improbable that the corrugated structure of the lodes, which gives rise to the barrel quartz, is due to the difference in texture, and to the greater resistance to lateral pressure offered by the quartz layers than by the enclosing beds of clay and sandstone, which by their consolidation have given rise to the argillites and quartzites. There is, moreover, evidence that during the movement of the strata, openings and fissures were in some cases formed in these quartz lodes, giving rise to joints in which gold, metallic sulphurets, and carbonate of lime were afterwards deposited, apparently by solution and segregation from the adjacent parts of the lode.

It has been shown that gold-bearing lodes are met with at intervals through a great thickness of the auriferous series. As remarked by a writer in a late number of the *Mining Gazette*, these lodes in Nova Scotia generally, if not always, occur in groups, each of which may include twelve, twenty, or more lodes of various dimensions. Other portions of the series are without quartz lodes, or contain groups which are apparently destitute of gold.

It results from the interstratification of the auriferous lodes, and their exposure on the denuded crowns of the anticlinal that, unless there has been a vertical displacement along the line of the east and west anticlinal, we should expect to find each lode of the north side repeated on the south side of the anticlinal axis. This repetition of the veins is recognized by the miners themselves in some of the districts, and becomes of service in guiding explorers.

The elevations and depressions of the east and west anticlinal axes, caused by the transverse undulations, give to the outcrops of the strata which appear on the worn-down surfaces of the anticlinal domes, the form of more or less elongated ellipses, since the outcrops of the beds on the north and south sides of the axis must bend round towards each other, and unite whenever the plane of erosion intersects a north and south synclinal. Of this a fine instance occurs at Oldham.

While the slope of the beds on the two sides of the anticlinal axis will, unless the beds are vertical or present an overturn dip, be in opposite directions, it is easy to see that in the case of a synclinal the layers, being arranged in a basin, will dip towards each other from the opposite sides. The main anticlinal already spoken of are, as is always the case, accompanied by subordinate parallel undulations, which affect, more or less, the distribution of the auriferous strata. Thus, according to Prof. Hind, a synclinal depression occurs in the crown of the anticlinal at Lawrencectown, and in a recent article, probably from his pen, in the *Mining Gazette*, we are informed that shafts are here being sunk on lodes situated on the opposite sides of the synclinal, and dipping towards each other at angles of forty-five degrees.

Mr. Campbell describes the outcrop at Isaac's Harbour "as presenting a succession of narrow parallel folds, in which the quartz lodes are arranged in a saddle-like form in the planes of bedding of the arched strata. The course of the lodes is in some cases interrupted by faults or dislocations connected with the transverse undulations already referred to, but these faults are comparatively few and of little importance." I am informed by Mr. R. J. Leckie, that on the west side of Isaac's Harbour, at the Lone Star Mine, a drift

has been carried about 150 feet along a quartz lode, lying in the bottom of one of these synclinal folds, the axis dipping gently to the westward, while workings have been carried upwards for some distance on both the north and south sides of this folded sheet of quartz.

The occurrence of the gold of Nova Scotia in interstratified lodes is by no means a singular fact in the history of gold deposits. The gold-bearing quartz lodes of Victoria appear, from the descriptions of Selwyn, to be for the most part true veins, cutting the stratification; but in the gold region of California, although such transverse veins are not unknown, by far the greater number of the auriferous quartz lodes appear as layers conformable to the stratification, often lying between the sandstones and slates which form the common rocks of the country, and sometimes, as in Nova Scotia, divided by thin interposed layers of argillite. These conformable lodes are generally exposed on the upturned edges of eroded anticlinals, but in one case in Nevada County a remarkable lode is mined, which is described as consisting of three distinct floors or bands, "having a very flat dip and seeming to form a kind of basin," apparently a synclinal form. For further descriptions of these gold-bearing lodes, see Whitney's *Geology of California*, vol. i, chap. 9.

The auriferous rocks of California belong to the Mesozoic period, being of Jurassic age, but those of the southern Atlantic States, which are probably like those of Nova Scotia near the base of the Paleozoic system, exhibit not less strikingly the same peculiarities of structure as those of Nova Scotia and California. The interstratification of many of the gold lodes of the Southern States has been noticed by more than one observer, but is particularly insisted upon by the late Prof. Emmons in his *Report on the Geology of the Midland Counties of North Carolina*, published in 1856. He there asserts that the gold deposits in the ancient rocks of that region occur in true beds, and that the precious metal was deposited with the sedimentary strata. It is not now, however, confined to these beds, but is met with both accumulated in their joints, and in regular quartz veins with sulphurets, traversing alike the auriferous beds and their accompanying strata, "showing that it has changed its position since it was first deposited." The gold-bearing beds of that region are frequently of soft argillaceous or talcose slate, and at other times slaty and talcose quartzites. These auriferous quartzite beds are sometimes white and granular, becoming vitreous, or passing into a kind of chert or hornstone; all of these varieties of rock are, in different localities, wrought for the gold which they contain disseminated, while beds interstratified with them are destitute of the precious metal. It is in a bed of cherty quartz, resembling buhrstone, and mined for gold, that the peculiar silicious concretions supposed by Dr. Emmons to be of organic origin, and named by him *Paleotrochis*, are found. It is interesting to observe that in North Carolina, as in Nova Scotia, the gold is not confined to the vitreous or cherty quartz layers, and that beds of slate may be found profitable sources of gold. With reference to the sedimentary origin of the gold, asserted by Emmons, I conceive that although this metal is often mechanically present in sediments derived from the ruins of older auriferous rocks, the gold of the ancient strata, both of North Carolina and Nova Scotia, was brought to the surface in a state of solution, and that the watery solvent held also alike the elements of the accompanying metallic sulphurets and the silica which now forms the quartz layers.

Returning now to the consideration of the quartz lodes of Nova Scotia, we find that they are sometimes enclosed in quartzite, and sometimes in clay slate. In the greater

number of cases, however, they appear to be underlaid by thin beds of argillito, and overlaid by quartzite, the presence of one wall of soft fissile rock being very favorable to mining operations. The thickness of the quartz lodes varies from a few lines to six feet or even more, but this great thickness is seldom continuous, and it may be said that the thickness of the lodes mined is generally from four to fifteen inches. The same lode is subject to considerable variations in thickness in different parts of its course; but in several cases lodes have been traced without much change for distances of half a mile or more.

Considerable differences may be observed in the character of the quartz in different lodes, of which Prof. Silliman has distinguished two classes; the first consist of crystalline quartz, often quite white, and usually having the gold in coarse visible particles, which, like the associated sulphurets, show a tendency to crystallization. The second class he designates as lodes of slaty structure, the quartz being lamellar or fissile in planes parallel to the bedding, and the faces of the laminæ showing the fluted or grooved structure which is seen on the surfaces of the beds of quartzite and of the more homogeneous lodes. The color of the quartz in these lodes is dark, sometimes bluish or blackish, and its lustre is oily rather than vitreous. The gold in them is usually finely disseminated, and lies in plates near the borders, or is invisible. It is difficult to say which of these two kinds of quartz is the more productive, as examples of rich lodes of both varieties may readily be cited. To this description of Prof. Silliman I will add, that lodes showing a passage from the one to the other of these varieties of quartz, are met with, and that coarse gold sometimes occurs in the blue and oily looking quartz, which occasionally approaches to chert or hornstone, and sometimes assumes the aspect of a gray vitreous quartzite. In Tangier, according to Prof. Silliman, the quartz lodes often present a striking similarity to the harder slaty bands, as if they were these in some altered condition.

In addition to gold, the quartz lodes generally contain metallic sulphurets, of which mispickel or arsenical sulphuret of iron is the most abundant, after which may be mentioned cubic and white iron pyrites, a dark colored blonde, and more rarely galena and copper pyrites; native copper and specular iron were also observed by Professor Silliman in the Tangier gold district, and molybdenite and antimony-glance are said to have been observed in other localities. Though the metallic sulphurets generally accompany the gold, they are sometimes absent from specimens of quartz very rich in the precious metal. Small portions of calcareous spar and of a ferriferous decomposing spar containing a large proportion of carbonate of iron, and sometimes enclosing gold, are also observed.

As already remarked, however, the metals are not confined to the quartz lodes; gold, both in thin plates and in grains of considerable size, is not unfrequently found in the clay slate, and even in the quartzite. Professor Silliman cites an example where visible gold having been observed in a band of quartzite mixed with slate at Montague, there was obtained from several tons of the rock more than an ounce of gold to the ton, and in many other instances gold in paying quantities is said to have been found in bands of slate. The slate underlying the quartz lodes, contains in many cases, mispickel in crystals or imbedded masses, sometimes many pounds in weight, and generally rich in visible gold. A single mass of gold weighing twenty-two ounces was, according to Professor Silliman, found imbedded in mispickel from the wall of the Belt lode in Montague, and mispickel rich in gold has also been found in Tangier, Oldham and Waverley. In the latter district grains and crystals of the mineral are found imbedded in the quartzite.

The gold of Nova Scotia is remarkable for its great purity, different assays showing a fineness of from 966 to 982 thousandths, so that its value is about twenty dollars the ounce.

With regard to the distribution of gold in the lodes of Nova Scotia, Mr. Michel remarks as follows : "In sinking a shaft upon a lode we must expect to pass through some portions rich, and others poor and even barren. The arrangement of the metal in the lode also offers great variations ; sometimes it is disposed in a single layer in the middle, and at other times in several layers parallel to the walls. These layers of disseminated gold are limited in their extent, and it is often only at some distance from their limits that we meet with other similar layers. I observed in very many cases that the visible gold was generally most abundant in the portions of the lode adhering to the slate, which is generally the foot-wall, and often itself highly auriferous."

"If the results obtained during the last few years in Nova Scotia show that the veins are irregular in richness, they demonstrate their continued richness in depth. I saw specimens rich in visible gold, extracted from depths of 105, 156, 180 and 215 feet respectively, in the districts of Mount Uniacke, Renfrew, Wine Harbour, and Sherbrooke, and I am aware that a shaft on the Tudor vein at Waverley yields at the depth of 185 feet quartz affording more than an ounce of gold to the ton. Such veins as these just mentioned, which, with a great regularity of form and position, have presented alternations of poor and rich quartz to the depths already cited, will probably be found to offer similar variations to much greater depths. To abandon a working on account of a momentary impoverishment of the lode, as has too often been done in this region, is therefore, unwise ; and in a large enterprise, where mining is carried on in several veins at a time, the richness of some of these may always be counted upon to compensate for the temporary poverty of others. I am of the opinion that an unnecessary discouragement has had as much to do with the failure of certain gold-mining enterprises in Nova Scotia as the want of scientific knowledge and the neglect of proper preparations, and that many of those now abandoned as unprofitable, will be again taken up with advantage."

ALLUVIAL GOLD.

The absence of any considerable amount of superficial soil from a great portion of the surface of the gold-bearing rocks of Nova Scotia, has already been noticed, and is doubtless due to the force of the denuding agency which has borne away into the Atlantic a great portion of the matters derived from their abrasion. Sable Island, distant about ninety miles from the coast of Nova Scotia, is apparently nothing more than a belt of these detrital matters, rising in some parts to a height of ninety feet above the sea, and according to Mr. Campbell, abounding in gold. The general direction of the denuding force over this region, as shown by the grooved and striated rocks, is about fifteen degrees to the east of south. He adds that in nearly all the deposits of glacial drift or boulder-clay on the south coast, more or less gold is met with ; but its extraction is rendered difficult by the great tenacity of the clayey deposit, which is too expensive to work by ordinary means. It is only where the glacial drift has been re-arranged by water that gold can be found sufficiently concentrated to make it worth working. Gold washings have been wrought with considerable returns at Isaac's Harbor, Wine Harbor, Tangier Harbor, Gold River and the Ovens,—and Mr. Campbell has called attention to many other localities of

auriferous gravel, and especially to a considerable area of this kind in Cape Breton, to be noticed farther on.

The existence in Nova Scotia of gold-bearing alluvions older than the boulder-clay is a contingency not to be lost sight of; the presence of considerable quantities of gold at Gay's River in Colchester County, in conglomerate beds at the base of the Carboniferous series, which are nothing more than consolidated alluvions of that period, shows the great antiquity of alluvial gold in this region. In the province of Quebec the boulder-clay is generally destitute of gold, but in his report on the gold deposits of that province, (*Geological Survey*, 1866, pages 61, 65 and 87) Mr. Michel has shown that beneath this sterile clay is an ancient deposit of alluvial gravel abounding in gold, of which the rich washings of the Gilbert River in the Chaudière district are an example.

Analogous conditions are presented by the rich alluvial deposits of Victoria, Bolivia, and California. Mr. Michel, therefore, insists upon the importance of carefully searching in certain parts of Nova Scotia for similar ancient alluvions beneath the boulder-clay or glacial drift. Such deposits, when we consider the abundance of gold in the quartz lodes of the region, may reasonably be expected to be of great richness.

ON GOLD WORKING IN NOVA SCOTIA.

The gold mines of Nova Scotia belong to the Crown, and the law of May 10, 1864, extracts from which will be given in an Appendix, regulates all questions as to their concession and working. In accordance with this Act, the Governor in Council may, on the discovery of gold in any locality, declare it, by proclamation in *The Royal Gazette*, to be a gold district, and assign limits and bounds to such district, which may afterwards be enlarged or contracted if desirable. Besides those proclaimed districts are numerous others in which gold has been found, but which are not yet proclaimed, and, in many cases, are unsurveyed. Of the proclaimed gold districts, the following appear in the monthly returns of the Chief Commissioner of Mines:—Stormont, Wine Harbour, Sherbrooke, Tangier, Montague, Waverley, Oldham, Renfrew, and Uniacke. The gold obtained from the other localities is classed in the official returns as coming from "Unproclaimed and other districts."

The above mentioned districts, with the exception of Stormont and Tangier, were visited by Mr. Michel and myself, in company, and we also went together to the district of Lawrencetown and to Upper Stewiacke. Repeated visits, for the purpose of more careful study, were afterwards made by Mr. Michel to the districts of Waverley, Renfrew and Uniacke. His opinions, and the results of his personal observations upon the mode of working, etc., will generally be given in his own language, and the portions translated from his manuscript report will appear as quotations. Before proceeding to describe the various gold districts, it will be well to notice briefly the modes of working and treating the mineral generally adopted in Nova Scotia. Under this head Mr. Michel remarks as follows:—

"The appearances furnished at the outcrop of the lode can only give an approximate notion of its attitude and relations to the adjacent rocks, to obtain which subterranean workings are necessary; and when the enterprise is to include several lodes, it becomes indispensable, before working them, to know their structure and the mode in which they are grouped. The successful direction of a quartz mine requires something more than a practical knowledge of the processes required for the extraction and treatment of the

mineral ; the science and the experience which provides for the future of the mining operations, and for the accidental variations of structure and arrangement sometimes met with in the veins, are not less necessary ; and it is to be feared that all of these conditions have not been fulfilled by many of the directors of mining operations in Nova Scotia. I make this remark in no spirit of criticism, and with no intention of a special application of it to individual cases, but only to explain, from my point of view, the reasons of the failures of many mining enterprises which have been ascribed to impoverishment or disappearance of the vein, or to various difficulties of working, which would never have surprised, embarrassed or discouraged a skilful and competent mining captain. There are still other causes to which the abandonment of workings, almost at their outset, is to be referred. These have often been opened on rich outcrops, rather with a view to speculation than to regular working ; so that we see, in many cases, mills built immediately after the discovery of the gold-bearing lodes, and before their value had been tested, with the object of attracting attention to the property, and to favor its immediate sale. Thus it happens that not unfrequently we find in this region abandoned workings, and mills neglected or in ruin."

"The mining in this region is, in some cases, by open workings, but more generally by means of shafts, and of drift or galleries communicating with them. These shafts serve at the same time for the miners, for the raising of the mineral, and for the drainage and ventilation of the mine, except in those cases where a separate ventilating shaft becomes absolutely necessary. The shafts, rectangular in form, are vertical or inclined according to the dip of the lode, of which they include the whole thickness ; and their timbering, which varies according to the greater or less solidity of the walls, is done as the sinking advances. When a certain depth has been attained, galleries or drifts for the extraction of the mineral, are opened to the east and west, along the direction of the lode. The working is thus carried on by successive stages, the sinking of the shaft being continued, so that its base is always lower than the lowest drift. In the removal of the contents of the lode, which is done by successive steps, or what is called *stoping*, two methods are adopted. In the one, called overhand stoping, the vein is taken down by working from below upwards ; while the other, called underhand stoping, the mineral is extracted by excavations from above downwards. In the latter method, the whole of the material removed is taken up to the surface, while in the former, the waste and refuse, maintained in place by scaffolding, serves to fill up the space, sustain the walls, and facilitate the continuation of the work. This method of overhand stoping, however, has the disadvantage that the sorting of the mineral has to be made in the drifts, with the risk of losing more or less of the small fragments, often very rich, which become lost in the piles of rubbish. To avoid the loss in overhand stoping, it is in some places customary to spread cloths or leather over the debris. When, however, the vein is removed by underhand stoping, the whole material is raised to the surface, and it is easy to collect the smallest particles of mineral. Hence this latter method is almost universally followed in the Nova Scotia gold mines, and has replaced the method of overhand stoping, which had been in some cases resorted to for a time."

"The machinery for raising the mineral from the shafts is very simple : a windlass over the mouth of the shaft, worked by one or two men, suffices for works of little depth, while for greater ones, a whim with one or more horses is employed. These arrangements suffice

not only for bringing up the mineral, but for raising and lowering the miners when there are no ladders in the shaft, and also for the removal of water in buckets, in the case where this is not allowed to accumulate in a well, to be removed by a pump worked by steam or horse power."

"In the gold-bearing quartz mines of Spanish America, it is customary, before stamping the mineral, to calcine it in heaps, where it is arranged in alternate layers with wood, which being kindled, burns for from twelve to twenty-four hours. The object of this calcination is to get rid of the sulphurets often present, which interfere with the amalgamation, and to render the quartz more friable and easily pulverized. This process, however, is said to have been abandoned in California, and is not used in Nova Scotia, although in several places furnaces constructed for calcination are seen. The reasons assigned for this are, by some, that the quartz is partly vitrified, which might happen with impure vein-stone; while according to others, the gain in product did not suffice to pay the cost of the process, which is but partially effectual in decomposing the sulphurets present in the ore. Prof. Sullivan, in his report on the Tangier district, estimates the cost of calcining the quartz, with wood at \$4 the cord, to be not less than \$1 the ton."

"The mineral in Nova Scotia is thus taken from the mine directly to the mill, where it is sorted, the barren portions rejected, and the material reduced to fragments of a proper size. Two plans have there been employed for pulverizing the quartz; the Chilian mill and the stamp mill. The former consists of edge wheels or cylinders of granite or cast iron, running in iron pans, but its use in Nova Scotia has been very limited, and is now almost entirely abandoned. Although well suited for assays, and for the treatment of rich ores and residues, the Chilian mill is not adapted to the working of large amounts of quartz containing only a moderate proportion of gold. For this purpose stamps are more generally had recourse to."

"There are two systems of stamps in use in Nova Scotia—those with square heads and those with round and rotating heads—but in both cases the stamp mill consists of one or more batteries, each consisting of a series of vertical rods, carrying at their lower ends the stamp heads, which are of cast iron, or, in some cases, shod with steel, and destined to pulverise the mineral in a rectangular box or mortar. This box is generally of a single piece of cast iron, and when of wood (which is preferable if, as is here the case, mercury is used in the batteries), requires for its bottom a heavy plate of iron. These stamps are raised by means of a horizontal shaft furnished with cams, which act upon collars fixed to the rods, causing these to rise vertically, and then, the cams ceasing to act, to fall by their own weight from a height of ten or twelve inches upon the mineral, which is introduced to the box by means of an opening placed behind the battery. Plates or dies of cast iron or of steel, round or square, according to the shape of the stamp heads, are fixed in the battery, beneath each stamp. During the operation a quantity of water sufficient to aid the pulverization and amalgamation, and to carry out the pulverized mineral, is supplied to each stamp, by means of tubes furnished with stop-cocks. In front of each battery is a rectangular opening, which is closed by means of a frame or moveable sash, covered with a fine screen or grating. Through this grating, the liquid mud formed by the pulverization of the mineral under water, and projected from the boxes by the blows of the stamps, passes out and flows over a series of fixed or oscillating tables, slightly inclined, and placed the one below

the other, at different levels, before being conveyed as waste or refuse to a place of deposit without. The metallic gratings in front of the batteries have generally from 160 to 200 holes to the square inch. The finer the grating the less the amount of material stamped in a given time, but the more complete the treatment. I am inclined to believe that many of the mill workers, not taking into account the smallness of the particles of gold, often invisible, do not pulverize to a sufficient degree of fineness. One of the exceptions to this, however, is found in the battery of the Provincial Company at Wine Harbour, which yields a material of great fineness, while it reduced with eight stamps only six tons in twenty-four hours."

"The frames which support the gratings are generally fixed vertically; although a slight inclination outwards, to favor the escape of the projected matters, is to be preferred. The stamp mills which I saw in the various districts of Nova Scotia have generally eight stamps, arranged in two batteries of four stamps each. In the Sherbrooke district, the mill of the Hayden and Derby Company consists of one single battery and two united, each of five stamps, and that of the Palmerston Company of one of four and two each of three. In the Waverley district the mill of Mr. Bürkner has twenty-four stamps, and that of the De Wolf Company sixteen, arranged in four batteries of four each. The duration of a stamp mill, and the regularity of its work, depends, in part, upon the solidity of its base; and I may remark, in passing, that the last mentioned mill, erected under the supervision of Dr. Krakowitzer, is peculiarly well constructed in this as in other respects, and has a foundation built of granite, from which it results that the trembling motion so apparent in many stamp mills, is scarcely perceptible in this."

"The stamp mill of the Ophir Company, in the Renfrew district, recently constructed by Mr. Peter Monteith, is particularly worthy of mention. The stamps, which are round, rotating, and shod with steel, present many advantages over square non-rotating cast iron stamps. It is maintained that the effect of a round stamp, which preserves in falling the rotatory motion communicated to it during its upward movement, is much greater than that of a square stamp falling without that motion. Experience has shewn that with the former a greater amount of rock is pulverized in a given time, and with less wearing of the stamp heads. The mill of the Ophir Co. has twenty-four stamps, arranged in six batteries of four, placed side by side. The weight of each stamp, with the rod, is six hundred pounds, the fall ten inches, and the number of blows from sixty-five to seventy in a minute. The liquid mud from the pulverization, passing from the battery through the grating, flows over four fixed tables, placed one below the other. The first, or uppermost table is the shortest, and is trapezoidal in form; the dimensions of the two parallel sides being three and a half and two and a half feet. The three succeeding tables are rectangular, and have respectively the lengths of seven, eight and six feet; their breadths being twenty-four, fourteen and twelve inches. In many stamps there are used besides fixed tables, others having an oscillating movement, which is in some cases lateral, in others backwards and forwards. Thus each battery of the De Wolf Company at Waverley has the first table fixed, while the three others below it are shaking tables, with a lateral movement."

"Steam power is employed for the greater number of the stamp mills of Nova Scotia. These of eight stamps I found to be worked by engines nominally of eight, twelve and

twenty horse-power, and reducing from six to twelve tons of quartz in twenty-four hours. The mill of the New Haven and Renfrew Company has an engine of thirty, and that of the De Wolf Company one of fifty horse-power, the most powerful in the mining region, and capable of being employed not only to move the stamp mill, but to raise the mineral and the water from the neighboring shafts."

"The two largest mills of Nova Scotia,—that of Mr. Bürkner at Waverley, and that of the Ophir Company at Renfrew, are moved by water power. The first, which has during a long time, treated thirty-six tons of mineral in twenty-four hours, has probably done more work, and certainly furnished a greater amount of gold than any other in Nova Scotia. The water-wheel of the Ophir mill has a diameter of sixteen feet and a breadth of eight feet, divided into two series of buckets. The force of the fall is estimated to equal fifty horse-power. This mill, with twenty-four stamps, reduces from twenty-four to twenty-eight tons of quartz in twenty-four hours, works with great regularity, and is conducted with great skill by Mr. H. M. Huff. Besides the water power, this mill is furnished with a portable steam engine of seven horse-power, which heats the water for the batteries, turns a circular saw for cutting wood, and could be made, in case of need, to work two of the batteries."

"The amalgamation of the gold in the batteries during pulverization, is adopted in most of the mills of Nova Scotia. This requires the introduction into the boxes at regular intervals, of small quantities of mercury,—the amount depending on the richness of the mineral. At the Ophir Mine, there is added at the beginning of the operation and subsequently, every four hours, a spoonful of mercury. After several days working, however, if the mineral is not very rich, the quantity of mercury is diminished; but if the contrary is the case, the additions are made more frequently. In this connection, I cite some valuable details from the work of Mr. Arthur Phillips on *The Mining and Metallurgy of Gold and Silver*, recently published in London. I may, however, remark that with the exception of two not very satisfactory trials made at Wine Harbour and at Lawrenceburg, the use of amalgamated plates within the boxes, has not been tried in Nova Scotia."

[When the method of amalgamation in the battery is adopted, the batteries are often provided with amalgamated copper plates about five inches in width, extending the whole length of the box; one on the feed side, and the other at the discharge,—the former being protected by the sheet-iron lining of the feed-hopper, and each having an inclination of from forty to forty-five degrees towards the stamps. When these plates are not employed, spaces for the accumulation of the amalgam are allowed between the dies and the sides of the box, and vertical iron bars are placed within the grating, between which the hard amalgam is found to collect. * * * * One ounce of gold requires for its collection about an ounce of mercury; but when the gold is in a finely divided state, the addition of another quarter of an ounce is thought to be advantageous. The proper proportion is, however, readily ascertained by watching the discharge. If any particles of amalgam, which may pass through, are hard and dry, a little more mercury must be introduced; but if, on the contrary, they be soft and pasty, or if globules of mercury make their appearance, the supply to the battery must be diminished. When the proportion of mercury has been properly adjusted, the amalgamation of the gold is completely effected, except in cases in which the ores contain large quantities of lead or antimony, and have been previously burned for the purpose of

expelling their more volatile constituents, by which treatment, the particles of gold often become coated in such a way as so interfere with their combination with mercury. When the proper proportion of quicksilver has been regularly introduced, and the rock contains coarse gold, from sixty to eighty per cent. of the gold saved is caught in the battery;—but when, as in the case of some of the ores of Nevada, the gold is in a very finely divided state, and is associated with ores of silver and other sulphides, the results obtained are less satisfactory. The amalgam resulting from the treatment of such ores contains silver, and, in some cases, affords from 300 to 400 thousandths only of gold, often producing a spongy amalgam of dark colour, made up of an aggregation of numerous finely divided particles.

* * * * This amalgam is exceedingly light, and is therefore difficult to collect, either by riffles, copper plates, blankets, or any of the other appliances commonly employed for the purpose. When, therefore, ores contain much lead or antimony, amalgamation in the battery is not to be recommended, since this spongy amalgam is more difficult to retain than the most finely divided gold, and a larger proportion of it floats off over the blankets, riffles, or copper plates which may be arranged for the purpose of arresting it. There is, besides, no evidence that battery amalgamation possesses, under any circumstances, a decided advantage, for gold ores not associated with sulphide of silver, over stamping without the use of mercury; and in some of the most productive districts it is seldom resorted to.] (See Phillips, pages 177, 179.)

“The inclined tables, whether fixed or oscillating, which receive the pulverized mineral from the batteries, are lined throughout with plates of copper, which are amalgamated or covered with a film of mercury. At the head of the oscillating tables, at the DeWolf mill, are placed small concave transverse reservoirs, partially filled with mercury, with which the matters transported by the water are brought in contact, by means of convex cross-pieces fitting into the mercurial reservoirs. In other cases, the tables are furnished with a series of small transverse grooves or riffles, also holding mercury, and serving to arrest the particles of gold in their passage. The slope of these, according to Phillips, varies from three and a half to seven degrees. We have already seen, that from sixty to eighty per cent. of all the gold obtained, remains, under favorable circumstances, in the battery; of that which escapes with the liquid mud, the greater part collects on the first table or at the head of the second.”

“When the working of a mine is properly conducted, and the supply of mineral is regular, the stamp mill should work day and night, except when stopped for repairs or for cleaning up, as the process of removing the amalgam from the boxes and tables is called. The frequency of this operation depends upon the richness of the mineral; but in many mills it takes place every week for the tables, and fortnightly for the battery. At the Ophir Mine, while the batteries are cleaned but once in two weeks, the amalgam from the tables is collected once in three or four days, and even daily, when the mineral is very rich in gold. This process, as I saw it at the mill of the Uniacke Company, is effected by a stream of water from a hose, which removes the sands from the tables and allows the amalgam to be gathered up from the plates. For the batteries, the stamps being raised, and the grating removed, a jet of water is employed to break up the compacted mass of partially stamped mineral, which fills the box; the larger fragments being removed by hand, until the amalgam accumulates at the bottom. The dies are then cleaned and taken up, and the

washed amalgam gathered into a mass, and added to that already obtained from the tables. The excess of mercury is then removed from this by pressing it in chamois leather, or in a closely woven wet cloth ; after which the amalgam is divided into balls of a proper size and heated in a cast iron retort, which is previously lined with a paste of clay and water, to prevent the adhesion of the gold. The portion of mercury which still remains with the gold being expelled by heat, its vapors are carried over and condensed in water, and at the end of the operation the gold remains in the retort in the form of spongy masses, which are melted in a crucible, and cast into ingots."

The pulverized mineral, from which the gold has been extracted by the process just described, is known by the name of waste or tailings, and still contains a portion of gold, which is often considerable in amount. This gold is, in part, in small particles adherent to, or imbedded in the grains of quartz ; but, in part, also inclosed in the metallic sulphurets generally present, which, as already mentioned, are often rich in gold. Regular and careful assays of the tailings from the Nova Scotia mines are as yet wanting ; but, according to Professor Silliman, in the case of quartz from the Belt lode of Montague, treated in a mill at Waverley, the tailings contained, on an average, 16 pennyweights of gold to the ton. Assays of the waste from the barrel quartz of Waverley, treated in a stamp mill at that place gave him nearly 15 dwt. of gold to the ton, while not over 8 dwt. had been previously extracted, thus showing a loss of nearly two-thirds of the gold present. At the Port Philip and Colonial Company's mines in Victoria, Australia, where careful assays of the tailings are regularly made, they are found, while the mean product of the quartz is about 9 dwt., to contain on an average 2 dwt. of gold. Of this, however, a considerable proportion is recovered ; the tailings are concentrated in bubbles, by which the sulphurets, carrying the greater part of the gold, are separated from the lighter quartz. These concentrated tailings, which contain, according to assays, from three to four ounces of gold to the ton, are roasted, and then ground with mercury in a Chilian mill, by which means eighty-five per cent. of the gold present is extracted. The whole cost of this process in Australia, including washing, roasting, and amalgamation, amounts to about \$13.00 the ton.

That a large amount of the gold from some of the Nova Scotia mines is enclosed in the sulphurets, and thus to a greater or less degree escapes the action of the mercury, would appear from the assays of the mispickel or arsenical pyrites. A sample of several pounds weight of this, from Montague, yielded to Prof. Silliman \$276 of gold to the ton, of which about two-thirds only were coarse gold. The pyrites extracted by washing from the tailings of two lodes at Tangier gave respectively \$93 and \$125, and that from another vein in the same region not less than \$180 to the ton of two thousand pounds. (See Prof. Silliman's Report on the Tangier District.)

Notwithstanding these results, the tailings are generally entirely neglected in the Nova Scotia mines, and with them, no doubt, large quantities of gold are lost, which might be advantageously extracted by concentration and roasting, followed by amalgamation either in the Chilian mill, the Wheeler or Hepburn pan, or, perhaps, better still, by the use of Plattner's process, in which the gold is dissolved out from the roasted ore by the use of chlorine. Prof. Silliman has suggested that the arsenic may be profitably extracted from the mispickel by roasting in properly constructed furnaces. By this means it might be made to yield half its weight of white arsenic, which has a considerable commercial value, and would probably pay the expense of roasting the ore. By thus condensing the arsenic,

the injurious effects which would otherwise result from the escape of the poisonous arsenical vapors into the air, during roasting, would be prevented.

The system of amalgamation in the batteries, generally adopted in Nova Scotia, is in many regions replaced by other methods, in which the whole or a large part of the gold is extracted from the pulverized quartz by washing. In the plan generally adopted, and for a long time practiced in South America, the rock is crushed beneath stamps, with the addition of water, but without mercury, and the material escaping from the batteries is made to flow over inclined tables covered, with coarse woollen blankets, or with bullock skins dressed with the hair on. These skins or cloths are removed from time to time, and the heavy material, rich in gold, is removed from them by beating and washing in vats arranged for its collection. At the Morro Velho mine, in Brazil, according to Phillips, 67 per cent. of the gold in the quartz is at once extracted by this process. Of the remainder a portion is lost in the slimes, but the greater part is obtained by grinding the concentrated tailings in arrastres, and washing again as before. From the rich material which collects on the cloths or skins the gold is extracted by amalgamation.

In other parts of South America the grinding of the tailings in the arrastre is performed with the addition of mercury, and the residual gold is thus amalgamated. The arrastre is a rude tub or basin of stone, having an upright shaft moved by horse-power, and carrying four arms. To these are attached, by chains, large blocks of hard stone, beneath which, as they revolve, the material placed in the basin with water is slowly ground to powder. The various iron amalgamating pans now in use are perfected forms of the arrastre, and some of them, as the Hepburn & Peterson pan, are said to be so constructed as to be very efficient grinders.

In the Grass Valley region, in California, the system of mechanical washing is also adopted, and for this purpose the sand and water issuing from the batteries are made to flow over a succession of tables, inclined at an angle of three or four degrees, and covered with a coarse gray cloth, woven for the purpose. In this way about nine-tenths of the gold obtained from the rock are extracted. The waste is then passed over tables with amalgamated copper riffles, by which a farther portion of gold is retained, and finally washed in buddles to collect the auriferous pyrites present. The arrangement just described is regarded by Phillips and by Silliman as the one most advantageous for the treatment of auriferous quartz. For plans and details of the method, as well as for descriptions of the various pans, and much valuable information on gold mining, the reader is referred to the excellent work of Phillips already cited.

It would appear from the Report of the Secretary of Mines for Victoria, for the year 1867, that a similar system is much used in that region where there were in operation, at the end of 1867, 5,529 stamp-heads, with 1,283 *riffle board tables* and 1,076 *blanket tables*.*

The fine pulverization of the gold-bearing quartz is a condition of the first importance

* The following additional statistics from the report just cited are not without interest:—It appears that there were employed in the colony of Victoria, during the last quarter of the year 1867, 13,970 quartz miners, while 800 square miles of auriferous ground, embracing 2,381 auriferous veins, were actually worked, and the value of the mining plant was £2,079,195. In the year 1866, the amount of gold extracted from quartz was 521,000 ounces, in addition to not less than 958,000 ounces of alluvial gold. The returns from the crushing of 861,468 tons of quartz were at the rate of 10 dwt. 16 gr. of gold to the ton, the number of quartz miners 14,378, and the average yield of gold for each, for the year, was £117 5s 7½d. Since the publication of mining statistics in Victoria there had been crushed, up to the end of 1866, nearly 4,000,000 tons of quartz, with an average yield of 11 dwt. 23 gr. of gold to the ton.

for the extraction of gold, and several attempts have been made to introduce more economical and more efficient means of pulverizing than are afforded by the ordinary stamp batteries. Of a system lately brought into use, Mr. Michel speaks as follows:—

"I had occasion, shortly before my visit to Nova Scotia, to see in operation at the Harvey Hill mine, in the province of Quebec, a new system of machinery, which promises to revolutionize the mechanical treatment of auriferous minerals. I speak of the mills of Messrs. Whelpley and Storer, of Boston, which consist of a crusher and a pulverizer, whose construction I shall not attempt to describe, but shall only mention the results which I saw. The apparatus at Harvey Hill was arranged for pulverizing the tender copper-bearing slates of that locality; but three trials were made in my presence with auriferous quartz from the Chaudière district, each trial upon one-third of a ton. Eighteen minutes were required to reduce one ton of quartz to a coarse powder fit for the pulverizer; and the latter machine in forty-two minutes reduced the ton of quartz to a powder as fine as that of most of the stamp mills in Nova Scotia. The quartzose copper slates of Leeds were pulverized much more rapidly, and reduced to an impalpable powder; and I am persuaded of the truth of what I was told by the mechanician in charge of the mills, that a similar result would have been obtained with the quartz, had the pulverizer been adjusted for the purpose."

It is proper in this connection to mention the use of sodium-amalgam in the extraction of gold. It often happens that a portion of the gold in the quartz, from the presence of an enveloping film, or from some other reason not well understood, is not readily moistened by the mercury, and consequently escapes amalgamation and is lost. The addition to the mercury of a minute proportion of sodium in the form of sodium-amalgam, however, causes the instantaneous amalgamation of the gold, whether in the batteries or in the subsequent treatment of the concentrated material in pans or otherwise. The published results of numerous experiments made with mercury containing a little sodium-amalgam, both in America and in England, show that the loss of gold is much less than with pure mercury, besides which the loss of a portion of mercury itself, by what is called flowering, and which is considerable with some ores, is entirely prevented, so that there appears to be a great economy in its use. Both Mr. Michel and myself have been able to test the advantages of sodium in numerous mechanical assays of gold-bearing quartz.

The use of sodium-amalgam for the extraction of gold, was first made known and patented by Prof. Henry Wurtz, of New York, and it has also been introduced into England by Mr. William Crookes, F.R.S., who for some purposes adds to the amalgam minute portions of zinc and tin. The use of sodium-amalgam has been adopted to some extent in Nova Scotia, but has probably not yet received the thorough trial which it merits. It appears, from the *Guide* of Mr. Heatherington, that it is employed in the mills of the Wellington Co., of Sherbrooke, and the Montreal Co., of Mount Uniacke.

NOTES ON THE DIFFERENT GOLD DISTRICTS OF NOVA SCOTIA.

In the following pages are brought together the principal facts of economic interest known with regard to the prominent gold districts of Nova Scotia, beginning with those nearest to Halifax. In addition to the personal observations of Mr. Michel and myself, I have

embodied much information from the reports of Messrs. Campbell and Silliman, already referred to and cited, and am moreover indebted for many important facts to the annual reports of the Chief Commissioners of Mines, and of the Inspector of Mines, Mr. John Rutherford. Many other statements are also given from recent numbers of the *Mining Gazette*, and occasionally from other sources considered reliable.

LAWRENCETOWN.

The gold district of Lawrencetown, as described by Mr. J. Campbell, lies in a deep valley extending northward from the head of Lawrencetown Harbor, about six miles inland from the sea shore, and twelve miles to the eastward of Halifax Harbor. The rocks are grey quartzites interstratified with bands of soft bluish shale, and the principal quartz lodes follow the dip and strike of the strata; but these are occasionally intersected by cross veins of quartz, some of them of considerable thickness. It would appear that considerable quantities of gold were obtained from this district in the earlier days of its working, when the land was divided into small lots of twenty by fifty feet. The surface of the soil was then, in many parts, covered with rich boulders of quartz detached from the veins adjacent, which were also readily mined, and often yielded rich products, even to the unskilled miner. Great numbers of small pits and excavations, dating from that period, are seen scattered over the surface, and are now sources of embarrassment to the systematic miner. It is certain that only a part of the gold extracted from all these workings could have been reported to the Commissioner of Mines; for the whole declared product of the district for the years 1861, 1862, and 1863 was only 240 ounces, and none whatever is reported for the four succeeding years, up to the present date. The want of success of an English Company, who constructed a mill, and commenced mining operations here, brought the district into disrepute; but within the last few months, it has begun to attract the attention of explorers, as well as of capitalists.

In his report dated January, 1868, the Chief Commissioner of Mines remarks that "the discoveries of gold-bearing leads, during the year, have been considerable, shewing a large surface for mining operations, and there is no doubt, from present appearances, that Lawrencetown will in the future be a leading district."

At the time of our visit, in November last, mining operations were in progress on two properties, that of Mr. John Werner, and that of Messrs. Capel, Townsend and Company; the first embracing 300 and the second 200 lots. These lots or mining areas, as defined by the present mining law of Nova Scotia, have a length of 250 feet along the course of the lodes, and a breadth of 150 feet, thus having a superficies of 37,500 square feet, equal to eighty-six hundredths, or in round numbers nearly seven-eighths of an acre. Owing to the rainy season, the pits on the Werner property were filled with water, except one of forty feet deep, which was examined. The vein was from nine to twelve inches wide, of bluish quartz, and showing grains of gold and of blende, with considerable mispickel. A mill of eight stamps, to be moved by water-power, was in progress of erection, and according to a statement in the *Mining Gazette* for March, was in operation and yielding an ounce of gold to the ton of quartz.

The Capel-Townsend property embraces several groups of gold-bearing veins; that which we were able to examine, known as the Waddilow group, includes thirteen, of which

five are visible in a breadth of about fifty feet, all running eastward, with a southward dip, and varying from four to nine inches in thickness. We examined two of these veins, which had been opened by shafts of thirty feet, communicating by a gallery. Windlasses worked by hand were employed for the service of the mine. The quartz, enclosed in slaty walls, was somewhat ferruginous, and contained, besides visible gold, copper pyrites, blende, and a little galena. Some specimens rich in gold were shown us as having been recently taken from these shafts, the quartz of which was said to have yielded 23 dwt. of gold to the ton. According to a recent number of the *Mining Gazette* the quartz from a vein of four feet is yielding 11 dwt. The position of this property appears to offer facilities for working by means of an adit, which would serve both for the extraction of the mineral, and for drainage, and would have its opening near the mill which it was proposed to construct on the site of the old one of the English Company already mentioned, where there is a water-power, sufficient, it is estimated, for forty stamps. This new mill, after some unsuccessful experiments, with imperfect machinery, is now said to be in operation. The wages of the miners in the Lawrencetown district, and in the gold fields of Nova Scotia generally, are about \$1.25 per day. Recent discoveries of gold in this vicinity have led the Chief Commissioner of Mines to enlarge this district to nine times its original size. Some interesting details as to its geological structure have already been given on page 10.

MONTAGUE.

The Montague gold district, which is situated between the lakes known by the names of Charles, Loon and Major, is about seven miles to the east of Halifax, and not far from Lawrencetown. The mines here at present, are in the hands of two companies, known as the Albion and the Union. During the four years ending with 1866, this district yielded more than 3,000 ounces of gold; but the works of the Albion having been abandoned during the past year, and those of the Union Company much reduced in extent, the declared product for the nine months ending with September, 1867, was only 417 ounces of gold; of which a large part was from the treatment of the old tailings from former workings, which were desulphurized and re-stamped, together with a certain amount of quartzose slate holding gold. The principal vein, known as the Montague or Belt lode, has been traced for a distance of half a mile east and west, and dips to the southward at a high angle. It is enclosed in two bands of slate, which separate it from the surrounding quartzite. A thin layer of the same material also divides the lode in two parts. The mean thickness of the lode proper, is about four inches; but in some parts it expands to ten, and even twenty inches. It has been wrought by the Union Company for a distance of about 500 feet, by means of long open cuttings, and by five shafts, one of which is 115 feet deep, but at the time of our visit in November last we found the mine temporarily abandoned on account of the great amount of water in the workings, which, being in part open cuttings, serve to collect the rains. This system, too often followed hitherto in Nova Scotia, cannot be too strongly reprobated. Very little difficulty will, in most cases, be experienced in the drainage of the mines in this region, if care be taken to keep out the surface waters. The quartz of this lode is highly crystalline, and besides gold, shows iron and copper pyrites, blende, and mispickel. These sulphurets, according to Professor Silliman, are most abundant near the band of soft underlying slate, which also contains scales of visible gold, and imbedded masses of mispickel of all sizes, up

to fifty pounds weight. This latter ore, as already described (page 20) is rich in gold, which occurs throughout it in plates and strings, and in one instance, formed, it is said, a mass of twenty-two ounces of solid gold. Several other gold-bearing veins are known here, one of which, of four or five inches, divided by thin layers of slate, also yields rich specimens of gold; and we examined a considerable quantity of rock extracted from a third and thinner vein, in which gold was visible in a decomposing ferruginous spar, which was associated with the quartz of the lode.

The mill of the Union Company, having two batteries of four stamps each, is erected about three hundred paces to the south of the principal vein, and has a steam engine of fifteen horse-power. It reduces in twenty-four hours, ten tons of hard quartz, or twenty tons of a soft slate traversed by little threads of quartz, which was being treated at the time of my visit, and yielded about 5 dwt. of gold to the ton.

The pyritous character of the mineral at Montague is such that special means are needed to separate, by concentration and subsequent treatment of the tailings, a large portion of the gold which escapes the ordinary process of amalgamation, so that it is probable that nearly one-half the gold in the mineral here obtained has been hitherto lost. As already stated, the assays given by Prof. Silliman showed, in the tailings from the Montague lode, more than 16 dwt. of gold to the ton. Attempts were made last year, on a small scale, to treat a second time these tailings, and with very profitable results: The mining operations here exhibit the want of a right system, which would secure the exclusion of surface water, a constant supply of mineral, and an economical working of the mine. We are informed that since our visit exertions have been made to improve this condition of things in the Montague district, and that a steam engine has been erected on the property of the Union Company, which will serve both for raising the mineral and for draining the mine.

There seems to be no good reason for the present neglected condition of this district, which, as we have seen, yielded in four years, not less than 3000 ounces of gold; the average produce of the mineral, in 1865, was, according to the Government returns, over \$29 to the ton, and \$513.85 for each miner.

WAVERLEY.

As described by Mr. Campbell, the Waverley district is upon a broad waved anticlinal, with nearly east and west strike. The quartz lodes, which are interstratified in the quartzites of the gold-bearing series, occupy a position a little over half a mile in vertical depth below the base of the clay slate division, and have, according to the same observer, a westward dip on the crown of the arch, of about one foot in ten, caused by a transverse or north and south anticlinal, which lies some distance to the eastward. Mr. Campbell, in this connection, calls attention to the frequent occurrence of dislocations or faults in the neighbourhood of these north and south lines of disturbance, producing local variations in the angle of inclination of flatings of the beds in different sections of the field, and occasional displacement of the lodes. These north and south lines of dislocation are often marked by cross veins of quartz, generally holding little or no gold, and often shifting the east and west veins in such a manner as to show that they were formed in transverse fissures, after the gold-bearing lodes were solidified.

The Waverley district is situated about twelve miles from Halifax, near the Windsor Junction on the Nova Scotia Railway. It appears, from the official returns, that of

97,600 ounces of gold produced in the province from 1861 to the end of September, 1866, not less than 34,395 ounces, or more than one-third came from the mines of Waverley; the average yield during that time having been 17 dwt. 12 gr. to the ton of quartz. In the succeeding year, ending with September, 1867, there were treated in the Waverley district 11,289 tons of quartz, yielding 4,135 ounces of gold, being an average of 7 dwt. 7 gr. to the ton. The number of workmen employed during the year ending as above, was, on an average, one hundred and eighty-one, and the return for each, \$422,—the ounce of gold being estimated at \$18.50. There has thus been a marked falling off in the produce of Waverley since 1866, a fact which is the more surprising, as the veins of this district are developed over a considerable length and depth, and have shown throughout a great persistency in the distribution of the precious metal. In his report of December 1, 1866, Mr. Rutherford, the Inspector of Mines, mentions the following lodes (all dipping southwards) as having been wrought in the Waverley district, during the preceding year: The Tudor and Brodie veins, having a thickness of from eight to eighteen inches, the first of these worked by Mr. Bürkner, by the Lake Major Co. and the DeWolf Co., and the second by the latter company only; the South vein, of fifteen inches, by the Hartford Co.; the Taylor and No. 6 veins, of fourteen inches, mined—the one by the DeWolf Co., the other by the Boston and Nova Scotia and the Waverley Cos. Since that time many of the companies then existing, and among others the Lake Major and Rockland Cos. have sold their interests to the DeWolf Co. This company now possesses, in the Waverley district, one hundred and thirty-one mining areas, a Chilian mill and two stamp mills,—one with eight stamps, and the other, an excellent mill, noticed on page 17, having sixteen stamps. Forty-seven shafts, and numerous drifts, both for extraction and drainage, are already opened on the veins belonging to the Company. The depths of these shafts vary from 100 to 250 feet, and upon the Tudor vein is one of 300 feet, in which is a pump worked by steam power. When we visited this district, the large mill just mentioned was chiefly supplied with mineral from the North or Brodie vein; but the working was on a limited scale. It is to be hoped that renewed activity will be given to this exploitation, which is already on so large a scale, and furnished with such excellent appliances. According to the information then received, the actual cost of extracting the mineral varied from \$3 to \$5 the ton, and that of stamping and amalgamation was \$1, or, by another estimate, \$1.50.

The property of Mr. Leopold Bürkner, including two hundred areas, of which only ten are as yet explored, extends to the westward of the last, on the continuation of the Tudor and Brodie veins. Of nine shafts which have been sunk on the first of these veins, connected by a gallery of about 400 feet long, and have attained depths of from 100 to 250 feet, five have yielded mineral of great richness to considerable depths. That extracted from shaft No. 2, at a depth of 180 feet, gave over an ounce of gold to the ton. The quartz from all of these openings is extracted by underhand stoping; the plan of overhand stoping, at first adopted, having been quickly relinquished on account of the hardness of the rock. When we visited the property of Mr. Bürkner, all of the shafts on the Tudor vein were for the time abandoned, and of five on the Brodie vein, two only were being wrought, one at a depth of eighty, and one at thirty feet, which furnished eighty tons a month of quartz yielding 10 dwt. of gold per ton; the whole cost of extraction and amalgamation not exceeding \$5.25, the working of these two shafts thus gave a monthly profit of \$400.

Mr. Bürkner had also, at that time, several trial pits on the South vein, about a quarter of a mile south of the Tudor vein, which had already given satisfactory results. This vein is observed, in its western prolongation, to turn towards the northwest, assuming a southwest dip, and will probably be found to join one of the veins on the north side of the anticlinal axis. Numerous other lodes have been observed in the Waverley district, some of them within, and others without the limits of the properties already mentioned, but they have not as yet, for the most part, assumed any special importance. The barrel quartz of Laidlaw's Hill, in the eastern part of the district, is, however, to be excepted. This has already been noticed, and its structure explained on page 8. It is apparently a quartz lode exposed on the crown of an anticlinal which runs a few degrees to the north of east. The corrugations generally present the form of wave-like undulations, rarely that of tight folds, and in one exposure, a little to the westward, the same, or another quartz lode, appeared as a nearly horizontal sheet. A shaft sunk about forty feet south of a point where the barrel quartz was found at a depth of twenty feet, failed to meet it at sixty feet, showing apparently a rapid southern dip of the lode on that side. A similar corrugated structure, to some extent, was observed in another lode farther west, which dipped about forty-five degrees to the southward. The barrel quartz is somewhat banded in its structure, and holds calcite in parts, apparently a subsequent deposit, filling fissures in the quartz. A similar case was observed in the highly laminated lode of barrel quartz from Upper Stewiacke, where both calcite and pyrites have evidently been deposited in irregular cross fissures in the lode. (See pages 10 and 11.)

In 1862 and 1863, this deposit was extensively mined, and offered great advantages from the facility and cheapness with which the quartz was extracted. Thus it appears, from the report of the Chief Commissioner of Mines for 1863, that during the last three months of 1862, the average product of each miner on the barrel quartz was nine tons a month, while in other localities it did not exceed two or three tons. Some portions of this quartz have been exceptionally rich. Thus a mass of about two cubic feet was extracted in 1862, from which gold to the value of \$4,500 was obtained, while the adjacent portions of quartz, for a considerable distance, proved to be quite barren. The average yield of the barrel quartz, in 1863, was said to be not over 5 dwt. to the ton. The great loss of gold observed by Prof. Silliman, in the treatment of this quartz, has already been noticed on page 20. After having been abandoned over three years, the mining of the barrel quartz was resumed in 1866, by Mr. DeWolf. The previous workings had been by stripping off the overlying rock and quarrying the bed of quartz in the open air; but it is now extracted by means of narrow subterranean cuttings, the openings, after the removal of the auriferous quartz, being filled up with the waste rock. The ordinary thickness of the barrel quartz is from eight to twelve inches; but it is subject to considerable variations. Its ordinary yield in gold is said to be at present from 6 dwt. to 10 dwt. per ton; though rich specimens are occasionally met with. Mr. Bürkner, who has two areas of the barrel quartz, employed upon it, at the time of my visit, twelve miners, who got out 100 tons a month. The total cost of the extraction and treatment was \$4.50 the ton, which gave an average of 7 dwt., giving thus a clear monthly gain of \$250.

We have already spoken of the stamp mill of Mr. Bürkner (page 18). It has twenty-four stamps, weighing 780 pounds each, with cast-iron heads. The lift of these is fifteen inches, and the number of strokes from fifty to sixty a minute. It is arranged with

oscillating tables, and has for its motive power a water-fall, whose force is estimated at 120 horse-power. The total cost of this establishment has been \$20,000, but Mr. Bürkner says that such a one could be erected for \$13,000. It has for a long time treated at the rate of from thirty-five to thirty-six tons of quartz in twenty-four hours. The cost of extraction of the quartz from the veins is from \$4 to \$9, according to their dimensions, and the cost of stamping and amalgamation from \$0.50 to \$0.75, according to its greater or less hardness. Mr. Bürkner himself directs the working of this establishment, from which he has already received large profits, and has employed two hundred workmen at an average of \$1.25 a day. According to the last report of the Chief Commissioner of Mines, there is probably no district in the province where mining is so economically carried on, and crushing so cheaply done as in Waverley, and he asserts that "a lode averaging fifteen inches in thickness is now worked at a depth of 300 feet at a cost of 8 dwt. to the ton." On account of the great depth of soil the workings have hitherto been chiefly confined to a very narrow belt, and the district is as yet but very imperfectly explored. It is not easy to explain the falling off in the produce of Waverley, but it can hardly be attributed to impoverishment, and still less to exhaustion. In the opinion of Mr. Michel, most of the present workings "have reached the greatest depth at which they can be profitably wrought under the present conditions, and will require, for the future, special arrangements and powerful machinery to make the veins productive." Meanwhile there is an extensive field for exploration.

We had not time to examine the workings of the Boston and Nova Scotia Company; but Mr. Rutherford in his Report for December, 1866, tells us that this company had sunk on the No. 6 vein, to the south of the Tudor, four shafts, one of them 180 feet in depth. On the west side of this latter shaft the lode had been stoped from the surface to within a few feet of the bottom of the shaft, while a good deal of stoping had also been done to the eastward. The lode had a thickness of fourteen inches. From what we were told when at Waverley, it appears that the company still continued these workings, and was then extracting quartz which yielded over an ounce of gold to the ton, from a shaft of ninety feet on the North vein. Their mill of eight stamps is worked by a steam engine.

To treat thirty-five tons of hard quartz in the mill of Mr. Bürkner there are required the labour of five breakers and feeders, making ten for the twenty-four hours; but for softer slaty mineral eight are sufficient. Besides these, the services of a skillful mechanic or engineer are required.

The loss of mercury in the process of amalgamation, as carried on at Waverley, is but small; due care being of course taken to recover that which is separated in distilling the amalgam. According to Mr. Bürkner there were consumed, in the treatment of about 7,000 tons of quartz at his mill, 115 pounds of mercury, which, at \$0.65 the pound, is worth \$74.75, being very little over one cent for the ton of mineral. This is equal to nearly .017 of a pound of mercury to the ton; according to Mr. Ashburner's tables, the loss of mercury in different Californian mills varies from less than .003 to .030, and even much more. The cost of treatment in some of the water-mills of California does not exceed that of Nova Scotia, ranging from \$0.67 to \$1.04, though in many cases much greater. (Geology of California, Vol. 1., Appendix.)

OLDHAM.

To the northward of Waverley, and at a distance of five and a half or six miles, after passing over a trough partly filled by the strata of the clay slate division of the gold-bearing series, we come, says Mr. Campbell, to another great anticlinal fold exposing the quartzites. On this band, at a distance of two miles east from Grand Lake, the gold district of Oldham is situated. The horizon of the gold-bearing lodes, according to the same observer, is seen, from the section of the railway cutting, to be not much less than 2,500 feet from the summit of the quartzite division. The mines are opened in a deep narrow valley, which extends for some distance along the anticlinal, and have afforded very rich products. From 1861 to the end of September, 1866, this district yielding 5,208 ounces of gold, the average per ton being 18 dwt. 2 gr. In the succeeding year, to the close of September, 1867, there were treated only 960 tons of mineral, yielding 1,359 ounces of gold, being an average of 1 oz. 8 dwt. 7 gr. per ton. During the first quarter of the year thirty-six workmen were employed daily, and during the second quarter sixty-five.

The Oldham district is thirty-two miles from Halifax, and is reached by a public conveyance from the Enfield station on the railway—three and a half miles distant. At the time of our visit, on the twenty-sixth of last November, the workings were for the most part suspended—not more than thirty miners being employed. Of the five stamp mills, only one was in operation at that season, and even that was for the time undergoing repairs. This mill, belonging to Mr. W. Shaffer, was, we were told, supplied in part by the mineral from his own workings, but treated also the mineral furnished by other proprietors in the district, who paid at the rate of \$3.50 a ton for crushing and amalgamation. Mr. Shaffer had also a Chilian mill, which was then unemployed; but, according to the *Mining Gazette*, has lately treated seventeen tons of quartz with a yield of 23 oz. 4 dwt. of gold, and it would appear, by recent accounts, that there are signs of renewed activity in this district.

The workings of Oldham have generally been by open cuttings on the slope of the veins, sometimes carried to the depth of sixty feet. One of these, on the Hall lode, has a length of 160 feet, and attains, in parts, forty feet, at which depth the vein is said to be lost, but is perhaps only displaced by a dislocation. This vein is very irregular, and in some parts contracted to a slender seam, which is then very rich in gold. Besides these open cuttings, however, there are numerous shafts; one of these on the Britannia lode, which dips northward about seventy degrees, has attained a depth of 108 feet. There are said to be known in this district, about sixty parallel quartz lodes, running east and west, in a breadth of about half a mile. These lodes, corresponding to one-half that number of interstratified sheets of auriferous quartz, are symmetrically arranged on the north and south sides of the anticlinal axis, with opposite dips. They have been traced for about a mile and a half from west to east, but in this direction disappear from the effect of a north and south synclinal. Several of the more southern beds, having a south dip of from forty-five to sixty degrees, are seen to curve gently towards the north-east, assuming a south-east dip, which, in one case, can be followed till it becomes east-south-east. Four of these lodes have been more or less opened, and workings were going on in two of them for the purpose of extracting the quartz, which, along the side of a hill, was easily removed by stripping off the overlying beds of quartzite. The surface of these layers exhibited, in a marked manner, the ribbed or fluted appearance

already mentioned. These ribs, resembling, on a smaller scale, those of the barrel quartz of Waverley, were inclined downwards to the eastward, at a considerable angle, apparently coinciding with that of the east and west anticlinal axis. To the north of the axis a single northward-dipping lode has also been followed till it curves southward and assumes a north-east dip, evidently turning around to meet one of the southern lodes.

The thickness of the lodes in this district varies from one to fifteen, and in some instances twenty inches; and one to the south of the anticlinal, attains several feet. The enclosing rocks here, as in the other districts, are quartzite, more or less schistose, with bands of slate. Several transverse veins have been observed in this district, generally of small dimensions, and traversing alike the quartzite and the slate. One of these, as described to me by Mr. R. G. Fraser, of Halifax, is worthy of notice, as an exception to the generally sterile character of these cross veins. It was traced in a north and south direction, across beds of quartzite, for a distance of thirteen feet, between two east and west lodes, which were themselves poor in gold. This cross vein was twenty-four inches wide at the surface, but diminished to four inches at eighty-six feet, and to two inches at ninety-six feet, where it was abandoned. It was said to consist of quartz with some chloritic matter and a greenish dolomite, all carrying gold. Mispickel and the usual sulphurets were also found. From 185 tons of the matter from this vein there were extracted 519 ounces of gold. Bitter-spar, holding gold, was also met with in one of the east and west lodes, and calcite, with small quantities of pink orthoclase felspar, was found in thin seams in the slates.

The old workings in this district are of such a nature as to be often very embarrassing to those who would undertake systematic mining. They have been carried on without plan or forethought, and it would seem solely with reference to immediate returns, without regard for the future of the mining district; so that the whole field presents an appearance of great disorder. This is the more to be regretted, as the structure of the region is such that certain preparatory labours undertaken in common, and well directed, would have greatly facilitated the working of the veins. The richness of these is such that it appears probable that a judicious and skilful expenditure of capital would restore to Oldham its former productiveness, and make of it an important gold district.

RENFREW.

To the northward of the Oldham anticlinal, according to Mr. Campbell, we cross a belt of clay slate belonging to the upper division of the gold series, and occupying a synclinal, before arriving at the sixth and northernmost anticlinal of his section, on which is situated the Renfrew gold district. The mining operations at Renfrew, he tells us, have hitherto been confined to the lodes on the south side of the anticlinal, those to the north side being covered by a considerable depth of drift derived from the clay slates, or from the Upper Silurian rocks, which overlie the gold-bearing series a short distance to the north. Mr. Campbell detected large exposures of quartz in two localities to the westward, along this same anticlinal, one about ten miles distant, where the River Hébert crosses it obliquely, and where gold was found both in the drift and in the quartz; and another seven or eight miles farther westward, a mile and a half to the east of the post road from Halifax to Windsor, and about nine miles distant from the latter place. It is highly probable that careful explorations may detect, at some points along this line, other outcrops of the rich

auriferous lodes of Renfrew. In February, 1863, when Mr. Campbell wrote the report from which the preceding details are cited, the declared production of gold for Renfrew was only 508 ounces; but since that time, the yield has rapidly augmented,—the official returns from 1861 to the end of September, 1866, giving a total of 9,898 ounces of gold, with an average yield of 1 oz. 8 dwt. to the ton of mineral. During the succeeding year, ending September 30th, 1867, there were crushed in the Renfrew district 7,770 tons of mineral yielding 9,401 ounces of gold, which is equal to an average of 1 oz. 4 dwt. 4-gr. to the ton. The product for each laborer employed during these twelve months was not less than \$895.30. These figures suffice to shew the great prosperity of the Renfrew district, in which we found at the time of our visits in November and December, 1867, three mining companies in operation, employing in all 225 or 230 workmen.

The Ophir Mining Company, under the direction of Mr. H. B. Prince, was organised in 1866 in Boston, with a paid-up capital of \$100,000, in shares of one dollar each, which are now at a premium of seventy-five or eighty per cent. The property comprises nineteen lots,—the three upon which the principal mining operations are carried on, having been bought for \$1,600. Three lodes are here mined,—known as the North, South and Brook veins, which run east and west, with a dip of about forty-five degrees to the south. The first of these really consists of three contiguous veins, divided by slaty layers, the breadth of the whole being from eighteen to thirty inches. All of the material extracted from this lode, with the exception of some adhering fragments of sterile rock, is submitted to the stamps. Five shafts are sunk on this North vein, at intervals of 100 feet; they are numbered from east to west, and have, in this order, the respective depths of 60, 128, 130, 156 and 140 feet. They are connected by about 600 feet of galleries, opened at different levels, for the extraction of the mineral, which, as well as the water, was raised to the surface by means of horse-power. At the time of our departure, however, a pump was being fixed in the deep shaft of 156 feet, connected with a steam engine of twenty-five horse-power, which will also serve for raising the mineral from the adjacent shafts.

The three quartz layers of the North vein became so thin to the eastward, that the easternmost shaft was abandoned at the depth of sixty feet; but we were informed that to the westward, beyond the limits of the Ophir Co., they unite in a single vein of seven or eight inches. Upon the South vein, which is about one hundred and fifty feet to the south of the one just mentioned, six shafts have been sunk, numbered from east to west, and having, in December last, the depths of 145, 150, 165, 162 and 156 feet. The shafts, Nos. 1, 2 and 3, have distances of 120 feet between them; while the others are at intervals of 100 feet. Galleries for the purpose of extraction, having an aggregate length of 700 feet, have been opened at different levels, one of which, at a depth of fifty-five feet, starting from the shaft No. 3, connects the whole. The thickness of this vein in the easternmost shaft, is only three or four inches, but it gradually thickens towards the west, and in the shaft No. 6, attains a breadth of ten inches. The lifting of the mineral and of the water from the mine, was effected by horse-power, but preparations were at the time being made to drain the whole mine by means of a pump over shaft No. 5, to be worked by the engine on the North vein. On this account workings were temporarily suspended in some of the shafts of the South vein. The mining on the Brook vein, about 700 feet to the south of the South vein, consisted of a single shaft of the depth of seventy feet, from which the mineral and the water were raised by an apparatus moved by water power. The working

at the Ophir mine is by underhand stoping—the method of overhand stoping, at first adopted, having been abandoned on account of the inevitable loss from the falling of the small fragments of rich ore among the waste rock. The height of the benches varies from six to twelve feet. The sides of the vein are first taken down, and the barren rock is, as far as possible, separated, and placed behind on scaffoldings constructed for the purpose. The rich mineral is next removed, and taken down from stage to stage, to the place where the tubs for bringing it to the surface are ready to receive it.

The working of the Ophir mine is conducted in a systematic manner, and with great activity, as is shewn by the fact that 1,550 feet of shafts, and 1,300 feet of drifts had already been opened in the North and South veins. The veins are enclosed between a schistose quartzite, which forms the overlying rock, and a slate, which lies beneath. Gold is visible not only in large grains in the quartz, but also in plates and strings in the slates which enclose and separate the quartz layers. Rich specimens, exhibiting both of these conditions, were extracted in our presence from shaft No. 6, on the South vein. The tender slates which underlie, and are interlaminated with the quartz, are estimated to yield 5 dwt. or 6 dwt. of gold to the ton, and are stamped with the richer mineral. The North and South veins have preserved their general aspect and their richness with great regularity, to the depths already noted, and everything leads to the conclusion that the working may be carried on for a long time under favorable conditions.

We have already given, on page 18, the details with regard to the stamp mill of the Ophir mine, which we consider the best mill in Nova Scotia. From its establishment to December 1, 1867, it has pulverized and amalgamated 6,730 tons of mineral, yielding 9,795 ounces of gold. During the first four months of this time but sixteen stamps were in operation, and it is only since February, 1867, that it has been working with its full number of twenty-four stamps.

We were not able to examine the workings of the New Haven and Renfrew Co., and paid but a rapid visit to those of the Hartford Co., two Connecticut companies, both in successful operation, and under the direction of Mr. C. W. Allen. The property of the Hartford Co. includes ninety-five lots, upon six of which are known about twenty veins, from three to twenty inches in thickness. Eleven of these were counted in a breadth of about 250 feet. They are enclosed, like those just described, and have an east and west course, with a southern dip, but exhibit in one place an abrupt turn towards the north or north-west. The workings on this property, which were in great part suspended during our visit, consist of ten shafts, and as many galleries, the depths varying from 30 to 160 feet, and the length of the galleries from 75 to 150 feet. The mineral and the water are raised to the surface by horse whims or by windlasses. Besides gold, of which very rich specimens are met with, mispickel, galena, iron and copper pyrites are found in the quartz of these veins, portions of which yield 4 oz. of gold to the ton, the average being 2 oz. The stamp mill, which we saw in operation, is moved by a waterfall estimated to be equal to twenty horse-power. It consists of two batteries, each of four stamps of 700 pounds weight, having a lift of about ten inches, and making sixty-five or seventy strokes a minute. It is said to pulverize and amalgamate according to its greater or less hardness, from six to nine tons of mineral in twenty-four hours.

The mineral under treatment at the time of our visit, was from the McLeod vein, about a quarter of a mile to the north of the North vein. This McLeod vein, which has

like the others, a southern dip, and is about a foot in width. We saw upon it two shafts of eighty and ninety-five feet, situated about a hundred feet apart, in one of which work was going on. This same vein, further to the eastward, is mined by the New Haven and Renfrew Company.

The price of labour in Renfrew is from \$1.20 to \$1.25 a day. The cost of extraction of the mineral varies from \$5 to \$12, according to the size of the veins; and the cost of crushing and amalgamating from 50c. to \$1.50, according to the hardness of the mineral. At the Ophir mine, the cost of the mineral brought to the surface is estimated at \$7, and that of the subsequent treatment at 70c. the ton.

The Honorable Robert Robertson, Chief Commissioner of Mines, thus speaks of the district of Renfrew, in his Report dated January 10, 1868. "From being the third in rank last year, and the fifth in years previous, it has placed itself first this year, having produced nearly 900 ounces more of gold than any other district, and is only second in profit to Sherbrooke, each man employed having earned \$895.30 for the year. This result may well inspire the miners in depressed districts with confidence; since from being one of the poorest districts, it has in a short time become one of the most productive."

UNIACKE.

The history of this new gold district is given as follows, by Mr. Hamilton, the late Chief Commissioner of Mines, in his Report of December 1st, 1866:—Early in that year a party of explorers in the township of Uniacke, discovered lodes of gold-bearing quartz, which were so promising and attracted so much attention that before midsummer there was already taken up, under leases and prospecting licenses, a larger area than in any other gold district in the Province. The tract of land thus occupied belongs in part to the estate of the late Hon. Richard T. Uniacke, and its centre is nearly three miles in a northwest direction from the Mount Uniacke station of the Windsor Branch Railway. It is the most elevated gold-mining district in the Province, being about 560 feet above the sea level.

A road was laid out by the Government from the station to the new district, where a village of fifty houses has grown up within the past year. The successful results already obtained shew that the district is one of great promise. The official report for the year ending September 30th, 1866, shewed only 73 ounces of gold for Uniacke, the average product being 2 oz. 17 dwt. 5 grs. to the ton. The labors since that time have been in a great degree exploratory, and the results obtained, for the most part, are such as do not appear in the official reports. The published returns for 1867, shew, however, that there were treated, up to the 1st October last, 1,212 tons of mineral, yielding 947 ounces of gold, giving an average of 15 dwt. 15 grs. to the ton. The number of workmen having been on an average thirty, the product of gold for each one was \$584. The area over which auriferous lodes have been observed in this district has a breadth of about one and a half miles from north to south, and, it is said, not less than six miles from east to west. The dip of these lodes is nearly vertical, but with slight northward and southward inclination on the two sides of the field. Here, as elsewhere, there are examples of dislocations, probably connected with north and south undulations. The further study of this large area will doubtless present many points of geological interest. The lodes of Uniacke present similar characters to those of other districts already described, and are

inclosed in quartzite, generally with linings of slate. Their thickness varies from one inch to several feet, and the large veins are frequently divided into several layers by thin intercalations of slate. Besides gold, galena, iron and copper-pyrites and mispickel occur in the lodes, the latter in some instances in large proportions.

During our visits to Uniacke, in December last, we found two regular workings, and several explorations going on, occupying in all about sixty laborers. The property of the Montreal Company comprises twenty-one lots, in three of which are said to be about thirty veins, varying from an inch to four feet in thickness; one of these, named the Logan vein, had been opened by two shafts, one of which was then worked, and had attained a depth of fifty feet. This vein, which is from ten to twelve inches in thickness, is divided by several thin layers of slate. At a depth of about twelve feet was a gallery, extending for about thirty feet along the vein, from which quartz, rich in visible gold, was then extracted. The service of the mine was by means of a hand windlass. The stamp-mill of this Company has a steam engine and eight stamps, but leaves much to be desired as to its construction; it was, besides, only running at intervals, for the reason that the single small working did not suffice to furnish a constant supply of mineral. It is to be regretted that a property of such excellent promise should not be worked in a more efficient manner. According to the *Mining Gazette* for March, this company was then extracting quartz whose yield of gold was from three to four ounces to the ton.

The Uniacke Company, which is directed by Mr. Macintosh, was organized in Boston by Mr. C. T. McClure, who has also established the Ophir Company of Renfrew, and the Wellington and Palmerston Companies of Sherbrooke. The property of the Uniacke Company includes 121 lots, three of which are explored, and exhibit twenty-five veins, varying from six inches to ten feet in thickness. Three of these were mined at the time of our visit. The principal vein, designated the Old Lead, had a thickness of twelve inches, and was divided by several thin layers of slate. It was then yielding mineral holding visible gold, from a depth of 100 feet. The quartz is taken out from the drift by underhand stoping, and, like the water, is raised to the surface by means of a horse whim. The treatment of eighteen tons of this mineral, during one of our visits, yielded about 50 ounces of gold, or nearly three ounces to the ton. Mining was at the same time going on at another place, a few feet south of the Old lead, where a group of thin veins, up to an inch in thickness, occurs interstratified in a layer of slate. A little more than a foot of this lode is crushed, and was yielding about 2 oz. of gold to the ton; the mineral was extracted by an open cutting about fifteen feet deep. This same slaty band is mined at another point a little farther to the west, where it has a greater thickness, but is less rich in gold. Still another opening had been made on a vein of a foot in thickness, to the south of the last, and from a depth of 30 feet was said to yield 15 dwt. of gold to the ton. In these various workings, the rock and the water were raised to the surface by means of windlasses. The price of labor in this district is, on an average, \$1.25 a day. According to the *Mining Gazette* for March, the crushing of 117 tons of mineral by this company, early in February, yielded 132 oz. 16 dwt. of gold.

The mill of the Uniacke Co., constructed by Mr. Peter Monteith, cost, we were informed, \$3,000; it has two batteries of four stamps, weighing 600 pounds each, shod with steel, and is moved by an engine of eight horse-power. The lift was fifteen inches or more, and the strokes sixty-five in a minute. This mill pulverizes eight tons of mineral

in the twenty-four hours, and the amalgamation is effected in the batteries, which are furnished with fixed tables, covered with amalgamated copper plates.

The Mitchell vein, in this district, is worthy of notice as one of the few examples observed in Nova Scotia of a quartz lode enclosed between two walls of quartzite, without accompanying slate. This vein, which has a thickness of two or three inches, yielded near to the surface as much as 13½ oz. of gold to the ton, and its richness at fifty feet, though less, was still exceptional. Its working was at that time abandoned on account of its narrowness and the hardness of the rock. Other important gold-bearing lodes have been discovered in its vicinity, and are included in the property of the Alpha Company, recently organized, and possessing eighty-eight lots, with a mill of eight stamps, worked by steam power. Two small veins, to the north and south of the Mitchell vein, are noticeable from having been affected by numerous small dislocations, the effects of which are well displayed on the exposed surface of the hard grayish quartzite.

Interesting peculiarities may be observed in other parts of this district. Upon some lots there being explored by Mr. Bürkner, a group of small veins intercalated with slate is seen to form, 150 yards further to the east, two large veins, separated by a band of eight inches of slate; while not far off the reverse of this is observed in the case of a vein of two or three feet, which a hundred feet farther on is represented only by five or six small seams of quartz interstratified with slate.

We were unable from want of time, to visit the lots of the Westlake Company, and also those belonging to Messrs. Hall and McAlister, upon both of which explorations were being carried on with very satisfactory results. Further working of these properties have given products of unusual richness. According to the *Mining Gazette* for February, thirteen tons of quartz from a lode on the land of the Westlake Company gave not less than 234 oz. 6 dwt. of gold, or more than 18 ounces to the ton. This result is doubtless exceptional, but fifty-five tons from the same property are said to have since yielded 201 oz. 10 dwt., and Messrs. Hall and McAlister, from a depth of seventy feet, had extracted six tons of quartz, producing 22 ounces 7 dwt. of gold. The official reports for these few months are not yet received, but there seems no doubt of the great richness of the quartz lodes in this new gold district.

SHERBROOKE.

This mining district is situated near the sea coast, to the north-east of Halifax, and about 60 miles from New Glasgow, from which station, on the Nova Scotia railway, a public conveyance runs daily to the town of Sherbrooke on the east bank of the St. Mary's River near its mouth. The mines are on the opposite side of the river, and about a mile and a half from the ferry.

Gold was discovered here in 1861, and from that time up to the end of September, 1866, this district had, according to the official returns, produced 19,101 ounces of gold; the average yield for the whole time, being 1 oz. 16 dwt. to the ton. In the succeeding year, ending September 30, 1867, there were treated in this district, 5,809 tons of quartz, which produced 8,522 ounces of gold, or about one-third of the entire yield of the province for that period, the average being 1 oz. 9 dwt. 8 gr., to the ton of mineral. The average yearly product of gold for each miner in this district, for the last three years, has been equal to \$1,379.40, and for the last year, as may be seen by the table given in the Appen-

dix, amounted to not less than \$1,592.58. Sherbrooke, therefore, ranks first among the gold-producing districts of Nova Scotia.

The mines in activity at the time of our visit, on the 20th of November, 1867, were those of the following companies, viz.:—The Wellington, the New York and Sherbrooke, the Hayden and Derby, the Dominion and the Palmerston Companies, but their works having partially suspended during the winter, the whole number of workmen employed was not over 180.

The property of the Wellington Mining Company includes nine acres, upon which nine auriferous veins are known. Of these the principal is also mined to the east on the lots of Mr. Cumming, where it is said to have yielded $1\frac{1}{2}$ oz. of gold to the ton. Its thickness on the property of the Wellington Mining Company is from fifteen to twenty inches, and its dip about forty-five degrees to the north. It is worked by two shafts connected, at the depth of 140 feet, by a gallery. The eastern shaft, which had at the time of our visit a depth of 215 feet, was then yielding quartz rich in visible gold. The rock is raised by a steam engine of twenty horse-power, which also serves for the drainage of the mine. The lode is overlaid by a band of several feet of black slate, and it was in the portion adjoining this that the greatest part of the gold seemed to be accumulated. The yield of the mineral was said to be over two ounces to the ton; but according to the *Mining Gazette* for February, the treatment of 100 tons, completed on the 4th of January, gave 394 ounces of gold. The mineral is pulverized and amalgamated in a mill having four batteries of four stamps each, worked by a steam engine of fifteen horse-power, and capable of treating, according to its greater or less hardness, from sixteen to twenty tons of mineral in twenty-four hours. The tables are fixed, and have the form of sluices. This establishment is justly regarded as one of the best in the region, and employs about forty laborers, whose wages average \$1.20 a day.

The mines of the New York and Sherbrooke Company, and those of the Hayden and Derby Company are both situated to the westward of the Wellington. Our time did not permit us to visit the first; and we made but a rapid examination of the second, but obtained from reliable sources the following information with regard to these two establishments.

The New York and Sherbrooke Company have about forty lots, on which are known twenty-five lodes, varying from an inch to three feet in thickness, and running somewhat north of east, with a dip of about forty-five degrees to the northward. Although a dozen shafts have been sunk, only five of them, connected by drifts, were being worked at the time of our visit. The depth of the principal shaft was then 170 feet, and it was yielding quartz whose average produce was two ounces to the ton. The mill of eight stamps, with the shaking tables, is worked by a steam engine of fifteen horse-power. This establishment, like the last, employs about forty workmen, and although for some time in a depressed condition, is now progressing under skilful management.

The property of the Hayden and Derby Company consists of only seven lots, which contain a dozen gold-bearing veins of from two to twenty-four inches in thickness, dipping like the last. The working is carried on by six shafts, connected by galleries, and by an open cutting of 100 feet on a vein of from eight to fifteen inches. The mill has fifteen stamps in three groups; it is provided with shaking tables, and is worked by steam power. The mean produce of the mineral from this mine was said to be three ounces to the ton. This establishment employed, at the time of our visit, about twenty workmen.

The mines already mentioned, are situated to the north of the road passing through the village of Goldenville, which has been built up on this gold district. To the south of the road are the mines of the Dominion and Palmerston Companies. The first of these was organized in May, 1867, and includes nine lots, two of which have been wrought since 1863, and are known to contain about twenty veins, which offer many points of interest. To the south of the Dominion vein there are seen, in a small breadth, numerous veins running to the north of east, and nearly vertical, but with a slight dip to the southward. They have generally a layer of slate on the north side, separating them from the schistose quartzite, which here forms the predominant rock. To the north of the road, on the contrary, the black slates appear to prevail. These facts, taken into connection with the dip, would seem to show that we are here near the axis of the anticlinal, and that a repetition of the slaty portion, with its accompanying veins, but with a southern dip, may be expected southward.

Among the veins of the Dominion Company are two of about a foot each, separated by only the same thickness of quartzite. Two others, of eight and four inches, are separated at the surface by a considerable thickness of quartzite, which in descending becomes thinner, while the lodes augment, and finally, at a depth of twenty-five feet, unite in a single lode of about twenty inches. Several of these have already been found to be auriferous. The principal lodes are those known as the Dominion and Palmerston veins, the last about 100 feet to the north of the other. They were, at the time of our visit, wrought by means of two shafts furnished with windlasses, and each 85 feet in depth. At this level it was proposed from the Palmerston shaft to open two galleries, the one northward to the limit of the company's property, and the other southward to meet the Dominion vein—the sinking of the Palmerston shaft being continued to serve for the draining of the mine. The southern gallery was already being opened in November last, and according to the *Mining Gazette* for April, had intersected a mass of veins, which, in a breath of twenty-two feet, contained more than fifteen feet of auriferous quartz, upon which a level had been driven thirty feet to the westward. The future working will have for its base the Dominion vein, from which it is proposed, by transverse drifts, to communicate with the veins still farther to the southward.

It had been found necessary as a preliminary to the successful working of this property, to fill up the old workings, thus excluding the surface waters. Although the labors at the time were thus, in great part, preparatory, and with reference to the future of the mine, considerable quantities of quartz had been extracted, which was lately estimated at 800 tons. That from the Dominion vein holds visible gold, associated with iron and copper pyrites, and portions of chlorite, which also forms thin slaty layers in the Palmerston vein. In the latter the gold is associated with mispickel. The working during the winter employed only about twenty men, who received on an average \$1.25 a day. The construction of a stamp mill is in progress, but was wisely deferred until the preliminary labors should have opened the ground to such an extent as to ensure a constant and abundant supply of mineral. The skill and forethought displayed by the director of this mine, Mr. Stephen Goodall, not less than the abundance and apparent richness of the mineral, are such as should secure the success of this mining enterprise.

To the west of the Dominion Company are two other workings, those of the Boulder mine and the Palmerston Co. At the former there was but a single shaft, then at a depth of 63 feet, from which, by means of a windlass, was being raised quartz, seemingly rich in

gold, and charged with mispickel. Our time did not allow an examination of the Palmerston Company's mine, but as it is an establishment too important to be passed over in a notice of the district, we cite the following details from Mr. Heatherington's Guide to the Gold Mines of Nova Scotia, already referred to. This company was organized in Boston, in November, 1866, with a capital of \$100,000, American currency. The shares, originally of \$1 each, now bring \$2.15. The property of the company consists of 29 lots, of which only four are now worked. The average yield of the mineral, including portions of the slate which are crushed with the quartz, is stated at one and a quarter ounces the ton, and the mean cost of extraction and treatment is \$6.70. The company employs 40 miners, and owns a mill and shaft-house worth \$6,000. The yield for some time past has been at the rate of 200 ounces of gold per month.

The financial statement of this company from its commencement, as given in the *Mining Gazette* for January, is as follows, in American currency:—

Receipts from November 10, 1866, to October 28, 1867	\$85,515.59
Expenses at the mine.....	\$35,166.61
Cost of erecting ten-stamp mill.....	7,287.50
	\$42,454.11
Net profit.....	43,061.48
Deduct dividend of 25 per cent..	25,000.00
Balance.....	\$18,061.88

We saw the mill of the Palmerston Company, which consists of a single battery of four, and two united of three stamps each, and has a steam engine of ten horse-power. The lift of the stamp is about twelve inches, and the number of strokes was seventy per minute. This mill was said to treat on an average, ten tons in twenty-four hours, and is provided with tables having lateral oscillations.

The total yield of the Sherbrooke district for the twelve months ending December 31, 1867, was 9,463 oz. 18 dwt. of gold; being an increase of 3,634 ounces over the produce of the preceding year. The returns for the month of January, 1868, show 4,368 days' work, 600 tons of ore raised, 550 tons crushed, and an average yield of 1 oz. 3 dwt. 13 gr. of gold to the ton of 2,000 pounds; the gross product having been 647 oz. 1 dwt. 6 gr. Great activity exists in this district, and several new companies have been organized since the date of our visit.

WINE HARBOR.

This gold-mining district is situated ninety miles eastward from Halifax, about ten miles from Sherbrooke and four miles from the mouth of the St. Mary's River. The auriferous quartz lodes are met with over a belt of nearly a mile from north to south, and are in thick bedded quartzite, generally associated with thin layers of finely laminated bluish shale, which greatly facilitate the process of mining. The attitude of the lodes, which are here, as elsewhere, regularly interstratified with the enclosing rock, is nearly vertical, and their course about east and west. They are occasionally displaced by transverse dislocations.

The gold district of Wine Harbor was for some time one of the most prosperous in the province, and its falling off during the last two years is not apparently due to any decrease

in the richness of its mines. According to the official returns, this district yielded from the discovery of gold in 1861 to the end of September, 1866, 13,402 oz. of gold, the mean produce being 1 oz. 3 dwt. to the ton of quartz. In the succeeding year, ending 30th September, 1867, the whole amount of mineral treated was only 1,667 tons, yielding 764 ounces of gold, or but 8 dwt. 13 gr. to the ton. At the time of our visit in November last, three mines only were in activity, employing in all about fifty miners, the workings being partly suspended.

The Eldorado Company has thirty-two lots, upon two of which are known five veins from six to eighteen inches in thickness. Several shafts, one of seventy feet, are said to have been sunk on this property, where, however, we saw only a single work in progress, employing five or six men. This was an open trench at the level of high water, running north-northeast, with the design of meeting at a distance of 500 feet, the shaft of 70 feet which is sunk on the so-called Middle vein. This cutting, which had at that time a length of 330 feet, had not intersected any vein of interest. The workings at the Middle vein had been interrupted on account of the water in the excavations, but the richness of the material which had been previously extracted from this vein, was such as to justify the construction of this gallery. This company has a mill of twelve stamps, and a pump for the removal of water, both worked by steam power.

The Orient Company has thirteen lots on the point of land known by the name of Barasois, upon which numerous veins have been discovered; of these, the principal, which we examined, known as the Rankey vein, had a course a little to the south of east, and dipped, at a high angle to the northward; its thickness was from ten to twelve inches. It was opened in 1866 by means of four shafts, two of which have reached depths of 90 and 100 feet, and are connected by a gallery of 150 feet. The surface was here covered with twenty-five feet of soil. We were unable to get more precise details relative to this mine at the time of our visit, the operations being then suspended, and the mill taken down, preparatory to the erection of a better one. The average yield of the mineral from the lode has been 17 dwt. of gold to the ton.

The company recently organized under the name of the Provincial Company has thirty eight lots, upon which are known six nearly vertical veins, from three inches to three feet in thickness. Many of these lots have been worked since 1862, and have yielded large returns to the different parties formerly owning them. One of these, the Caledonia Company, obtained in six months \$200,000 of gold. The most important workings on their property have, however, been on the so-called Hattie lode, which appears from the report of the Inspector, Mr. Rutherford, in December, 1866, to have embraced several veins of different thicknesses, included in a breadth of seven feet. At that time several shafts had been sunk to depths of from 70 to 183 feet, and nearly all the lode between these had been removed.

The Hattie lode is about 700 feet to the southward of the Middle vein, and so near the margin of the sea that it has been found necessary to exclude the waters at high tide by means of a dyke. The four shafts sunk upon this lode on the property of the present Provincial Company are from 90 to 240 feet in depth, and a gallery 300 feet in length has been opened at a depth of 180 feet.

The raising of the mineral and the drainage are effected by means of a steam engine, which has cost \$8,000. The quartz which we saw taken from the depth of 180 feet was

rich in visible gold, particularly near to the walls, where it was seen in large grains, and we were assured that the average produce was two ounces of gold to the ton. The mill consists of two batteries of four stamps each, with fixed tables, and has a steam engine of twelve horse-power; its cost was said to be \$4,000. The weight of each stamp was 400 pounds, the lift ten inches, and the number of strokes sixty-five in a minute. At the time of our visit, only one of the batteries was in operation. It reduces less than a ton in twenty-four hours for each stamp, but the pulverization is extremely fine, a condition which is very favorable to thorough amalgamation. This establishment employed at that time from twenty to twenty-five workmen.

Recent accounts shew a renewed activity at Wine Harbor, which has suffered from imperfect drainage and from the want of sufficient machinery, but under proper management, will probably again assert its old position as a rich gold-producing district. Considerable alluvial gold has been in former years obtained at Wine Harbor.

STORMONT.

The gold district of Stormont lies some distance to the eastward of Wine Harbor, and embraces within its limits Seal Harbor, Country Harbor, and Isaac's Harbor. Some details with regard to its geology and mineralogy have already been given, on pages 8 and 10, from the report of Mr. Campbell, according to whom the whole of the coast between Country Harbor and Isaac's Harbor presents quartz lodes, which might be mined with advantage. It appears, from the last report of the Chief Commissioner of Mines, that explorations with very satisfactory results were, last year, carried on at Seal Harbor, and also at Country Harbor, from which, however, there are no returns since 1862, when twenty-four tons of quartz yielded forty ounces of gold. Twelve miles beyond, at Isaac's Harbor, considerable mining work has been done, and with most encouraging results, as will appear from the official returns, which show, up to the 30th September, 1866, a total yield of 6,636 oz. of gold; the average yield per ton being 2 oz. 2 dwt. 1 gr. During the last year there were treated 1,149 tons of quartz, which gave 1,505 oz. of gold; being an average of 1 oz. 5 dwt. 8 gr. to the ton. The average number of miners employed during the year was forty-five, and the product for each man \$618.75. In his last report, the Honorable Commissioner of Mines informs us that "this year (1867), as compared with the last, gave an increase of 450 ounces, with a much smaller quantity of quartz crushed, and a larger yield per man." The great difficulty of access, except by water, has hitherto prevented the development of this large and promising gold district. Profitable alluvial washings were wrought here in 1862, but have since been abandoned.

TANGIER.

The first discovery of gold-bearing quartz in Nova Scotia appears to have been made in 1858, by Captain L'Estrange, R.A., in what is known as Mooseland or Old Tangier, about twelve miles from Tangier Harbor or New Tangier.

Both of these localities are included in the Tangier gold district, which is described as having a length of about fifteen miles and a breadth of two miles. At Tangier Harbor, according to Mr. Campbell, clay slate, generally blue, but sometimes olive colored, is the predominant rock, interstratified however with hard flinty bands stained with oxyd of manganese, and with beds of dark white-weathering quartzite. In the opinion of Mr.

Campbell the beds, which appear on the crown of the anticlinal, belong to the uppermost part of the gold series, of which only the summit has been exposed by denudation. The veins run nearly east and west, with the strike of the beds, and have a southward dip of from ten to thirty degrees from the vertical, as described by Professor Silliman in his valuable report on this district, made in 1864. These veins are subject to considerable variations in size, being sometimes reduced to mere films, and again rapidly assuming a considerable thickness. It is perhaps from irregularities of this kind, or from dislocations connected with the east and west folds, that the lodes have seemed in some cases to traverse the strata in dip. Professor Silliman describes the productive veins as parallel to the beds, which are however intersected by cross lodes, generally sterile. The productive veins offer the same general characters as those of the other districts already described. We were not able to visit Tangier, but cite the following facts with regard to its yield of gold:—

It appears from the official returns that from 1861 to the end of September, 1866, there were extracted 3,457 ounces of gold, the average yield being 18 dwt. to the ton of quartz. For the succeeding year however, ending the 30th September last, only 486 tons of mineral were treated in this district, yielding 395 oz. 18 dwt. of gold, being an average of 16 dwt. 7 gr. to the ton.

This district appears to have been injured by unskilful mining, and to have fallen into, perhaps, undeserved neglect; recently however attention has been again turned to it, and a vein opened in Strawberry Hill is said, by the *Mining Gazette*, to have afforded, in January and February last, 44 tons of quartz, which yielded 106 ounces of gold. The Moose-land, or Old Tangier field, is so difficult of access that few attempts have hitherto been made to work it; we however saw at Halifax, numerous specimens of extraordinary richness which had been extracted by Mr. Adams, of the Beneficiary Company of Boston, from different excavations made last autumn at Moose-land. One of these specimens weighed twelve ounces, of which eight were estimated to be pure gold. Since that time regular working has been established, and the returns are said to be large. The lodes here are described as numerous and as having a southward dip.

Considerable quantities of alluvial gold were obtained in 1861 and 1862 from washings near Tangier Harbor, the official returns giving from this source about 150 oz., but it is supposed that only a small portion of the gold then found was accounted for to the Government. One mass of twenty-seven ounces, the largest yet found in Nova Scotia, was obtained here. A small lake near Tangier Harbor, having an area of fourteen acres, and known as Copper's Lake, was a few years since drained, with the expectation of meeting in its bed a rich deposit of alluvial gold. There was found beneath a layer of mud and vegetable matter "a stratum of glacial drift and tough clay." Prof. Silliman informs us that "on sinking pits anywhere on the drained surface to the under-clay, and washing the dirt, gold is found in small unrounded nuggets, just such as are seen in the quartz, quite rough and free from any mechanical action." He found it accompanied by a heavy black sand, half of which was magnetic, the remainder consisting of titanic iron with epidote and garnets. The amount of gold, however, not being so great as was expected, this enterprise was abandoned.

THE OVENS.

This name has been given to a gold district embracing a peninsula on the western side of the harbor of Lunenburg, and comprises an area of a mile and a half long and three-quarters of a mile wide. Several small caves in the side of a promontory facing the sea have, from their fancied resemblance to ovens, given its name to the district. The rocks here exposed are referred to by Mr. Campbell to the same anticlinal as those of Tangier Harbor, and, like that district, exhibit chiefly the slaty upper members of the gold-bearing series. The strata are here nearly vertical, and have a direction, according to Mr. Poole, fifteen degrees to the south of west. There has as yet been very little quartz mining in this district, though gold-bearing veins have been found, and from recent accounts it appears that a mill is about to be erected there. The official returns from 1861 to 1864, shew 1,282 ounces of gold from the Ovens district, but none since that date; of this the greater part, over 1,000 oz., was from alluvial washings in 1861 and 1862, since which time the washings have been abandoned, though it is said that preparations are being made to work them during the present year.

Numerous other localities of gold-bearing quartz have been discovered, nearly fifty in all, but of the eighteen which have been officially proclaimed and surveyed, those already noticed include the only ones that have as yet assumed any importance. Among others to which some attention has been drawn are Gold River, Chester, Upper Stewiacke, Mosher's River, Chezzetcook, Musquodoboit, Ship Harbor, Sheet Harbor, Scrappy Lake and Killag. The latter is in Halifax County, about ten miles from Sheet Harbor, and on the east side of a tributary of the Middle River, called the Killag stream. Mr. Bürkner, the enterprising proprietor of mines at Waverley, is now preparing to erect a steam engine and stamp mill in this locality.

GAY'S RIVER.

This district, which has been already alluded to, deserves mention in passing, for although it has never hitherto assumed any importance as a gold field it is not without interest in a geological point of view. It is situated about twelve miles to the eastward of the Shubenacadie station on the Nova Scotia Railway, where, at Corbett's mills, on a small tributary of Gay's River, the upturned clay slates of the gold-bearing series are overlaid by nearly horizontal beds of a red and gray conglomerate belonging to the Carboniferous series. These beds are, at the mills, but a few feet in thickness, and are overlaid by a mass of drift, and by beds of stratified sand and clay. The slates are exposed in the channel of the mill-stream, and good sections of the overlying strata are seen in its banks. The lower portions of this conglomerate abound in flattened scales of gold, sometimes a quarter of an inch in diameter, and have been mined by means of levels driven into the banks of the brook at the junction of the two formations. A foot or more of the base of the conglomerate was thus removed, and being crushed and washed in a pan or rocker yielded rich returns.

Gold has also been found in the drift overlying the conglomerate, which is itself evidently but an ancient consolidated drift, dating from the Carboniferous period. A small quartz vein, having a dip to the east of seventy degrees, is said to have been detected in the underlying clay slates. Quartz veins without gold occur in the slate hills of the vicinity.*

*The above description of the Gay's River deposit is condensed from one copied into Mr. Michel's notes, from a source unknown to me.

CAPE BRETON.

In his report for 1863 Mr. Campbell has given some interesting notes of an examination made by him, of the north-western shore of Cape Breton Island, from the Strait of Canseau to Cape North. He found alluvial gold in the sands of two streams falling into the Gulf of St. Lawrence to the south of Port Hood, and in one of these, Long Point River, the precious metal was abundant.

Further to the northward, on the Margaree, the Bedeque, and the Wagamatcook or Middle River, which flow, in the lower part of their course, through broad rich valleys, cut out of Carboniferous rocks, gold was constantly detected in numerous trials made by washing gravel, not only from the river beds, but from the neighboring alluvial deposits, and in such quantities that Mr. C. expressed the opinion that gold washings on the north-east branch of the Margaree, and on the Middle River, would prove remunerative. The region has since been proclaimed a gold district, under the name of Wagamatcook, but we have no account of further explorations.

Gold was also observed along three streams near Chetticamp, the first one a little to the westward of that settlement, and two others about seven and fifteen miles to the eastward, known as Steep Mountain River and Lazare, or Red Point River. Beyond these to Cape North his search for gold in several streams was unsuccessful. The rocks along this coast, beyond the limits of the overlying Carboniferous strata, are described as apparently Upper Silurian and Devonian strata, much altered, and affected by undulations, whose general course is N. 20° E., so that an oblique section highly favorable to examination is presented by the shores of the Gulf. The north-western part of this region afforded no gold, but yielded evidences of copper, zinc and silver. The latter metals were observed on the Mackenzie River, which falls into Grand Ance or Limbo Cove. Here, besides veins of zinc ore (calamine), from three to nine inches in thickness, were remarked others of a soft spar holding native silver. In addition to this Mr. Campbell found native silver disseminated in small grains in the gravel of this river, not only near the Gulf but for several miles up its course.

CONCLUSION.

A table from the report of the Chief Commissioner of Mines, showing the returns of the gold mines of Nova Scotia for the year ending Sept. 30th, 1867, is given in the appendix to this report. In this table are given for each gold district the average daily labor employed, the number of mills with steam or water power, the number of tons of quartz crushed, the average yield of gold to the ton, the quantities of alluvial gold, the total amount of gold, and finally the annual return for each miner employed, the price of gold being estimated at \$18.50 the ounce, which, as we have seen, is considerably below the real value. A column giving the maximum yield per ton from each district has been omitted, inasmuch as it is deduced from the treatment of lots of ore of exceptional richness.

It is impossible to determine with precision the total amount of gold obtained from the mines of Nova Scotia since their discovery. The Department of Mines was not organized until 1862, and it was not until the following year that complete returns were obtained. From this it results that no accurate estimate can be given of the amounts of the amounts of gold obtained in 1860, 1861 and 1862, though they are supposed to have been not inconsiderable. The official returns for the last six years, based on the gold for which the royalty of three per cent. has been paid, are as follows:—

1862.....	7,275	ounces.
1863.....	14,001 $\frac{1}{2}$	"
1864.....	20,023	"
1865.....	25,454 $\frac{1}{2}$	"
1866	25,204 $\frac{1}{2}$	"
1867.....	27,583	"
Total.....	119,541 $\frac{1}{2}$	ounces.

The value of the above amount of gold, at the Government price of \$18.50 the ounce, is \$2,211,508 ; but at \$20, which is about the worth of the Nova Scotia gold, it amounts to \$2,390,081. If to this we add the unreported gold obtained in the first two or three years, we may conclude that the whole product has been equal in round numbers to about two and a half millions of dollars. This amount is doubtless small when compared with the production of regions like California and Australia, where the yield of some single mines surpasses the whole annual production of Nova Scotia. As we have seen in a note to page 21, the quartz mines of Victoria employed, in 1866, 14,878 miners, and yielded 521,000 ounces of gold. The mean yield to the ton of quartz was, however, only 10 dwt. 16 gr., and the produce for each miner £117.5s. 7 $\frac{3}{4}$ d. or \$570.71, while for Nova Scotia these amounts were respectively 17 dwt. 23 gr. and \$765. In Victoria the whole amount of quartz crushed up to the close of 1866 was nearly 4,000,000 of tons, with an average yield of 11 dwt. 23 gr., while in Nova Scotia it has equalled not quite 100,000 tons, with an average yield of over 20 dwt. of gold to the ton. It is to be remarked that with improved systems of mining and working, both in Victoria and Nova Scotia, poorer materials may be wrought with profit, so that while the average product of gold per ton diminishes, the return for each miner increases. We have but to consult the table given below to see that the produce for each miner is proportionate not so much to the richness of the quartz as to the skill and economy of the management, which, within the last year has raised the production in Renfrew and Sherbrooke to such high figures. It may however be affirmed that the average yield of gold to the ton of rock, and also to each miner, is greater in Nova Scotia than in any other auriferous region known.

It may well excite surprise that so little mining has yet been done in Nova Scotia, where gold is known to be spread over an area of not less than 6,000 square miles, and where, notwithstanding the want of skill of the early adventurers, and the lack of capital, such remarkable results have already been obtained. The lodes of this region, which are very regular in structure, have been shewn to preserve their richness to depths of 200 and 300 feet, and from their geological relations there is every reason to believe will continue unchanged to the greatest attainable depths. To this it may be added that the price of labor is moderate, not exceeding \$1.25 a day ; fuel, both wood and coal, cheap and abundant ; the region healthful, and easily accessible from abroad. When all these things are taken into consideration, it would appear that no other gold-mining region offers such inducements to the introduction of capital and skilled labor, and that these alone are required to make Nova Scotia one of the great gold-producing regions of the world.

I have the honor to be, Sir,

Your most obedient servant,

T. STERRY HUNT

APPENDIX I.

STATEMENT shewing the average daily labor employed, the amount of quartz crushed, the yield of gold per ton of quartz, the quantities of gold from alluvial mines, the yield of gold per ton in each district and in the whole province, and the value of the average yield of gold per man employed in mining, for twelve months ending September 30, 1867.

(From the Report for 1867, of Hon. Robert Robertson, Chief Commissioner of Mines for Nova Scotia.
Appendix B.; see *ante* page 43.)

DISTRICTS.	Average men em- ployed.	Crushing mills em- ployed Sep. 30, '67.	Steam Power.	Water Power.	Tons of quartz, &c., crushed.	Yield per Ton.	Alluvial Gold.	Total yield of Gold.	Average yield per man for 12 months, at \$18.50 per ounce.
	—	—	—	oz. dwt. gr.	oz. dwt. gr.	oz. dwt. gr.	—	—	—
Stormont (Isaac's Harbor).....	45	2	2	...	1149	1 5 8	.....	1505 2 11	\$618 73
Wine Harbor.....	33	4	3	1	1667	8 13	.....	764 9 9	428 60
Sherbrooke.....	99	5	5	...	5309	1 9 8	.....	8522 8 11	1592 58
Tangier	19	4	2	2	486	16 7	20 6 0	395 16 10	385 50
Montague.....	19	1	1	...	214	1 19 0	.....	417 13 21	406 60
Waverley	181	5	4	1	11289	7 7	.....	4134 18 17	422 63
Oldham	52	4	3	1	960	1 8 7	.....	1359 12 2	483 88
Renfrew	189	5	3	2	7770	1 4 4	.....	9401 2 10	895 30
Uniacke	30	3	3	...	1212	15 15	.....	947 1 17	584 00
Unproclaimed and other Districts.	9	2	1	1	117	1 3 4	28 15 15	135 0 21	278 55
	676	35	27	8	30673	17 23	49 1 15	27583 6 97	765 00

APPENDIX No. II.

The following numbered clauses are extracted from the present mining law of Nova Scotia, passed May 10, 1864, and include the principal points relating to mines of gold:—

1. The word *mine* in this chapter shall mean any locality in which any vein, stratum or natural bed of coal or of metalliferous ore or rock shall or may be worked. * * *

2. Gold-bearing quartz shall be held to mean all auriferous rock *in situ*.

3. Gold elsewhere than in rock *in situ* shall mean alluvial mines.

* * * * *

10. The Governor in Council, on being satisfied of the discovery of gold in any locality, may, by proclamation in the *Royal Gazette*, declare such a locality to be a gold district, and assign limits and boundaries to such district, and from time to time, enlarge, contract, or otherwise alter such limits.

11. Quartz mines shall, so far as local peculiarities or other circumstances may permit, be in general laid off in areas of one hundred and fifty feet along a quartz lode, by two hundred and fifty feet across, which shall hereinafter be known and described as areas of class *Number One*.

12. Areas shall be laid out, as far as possible, uniformly, and in quadrilateral or rectangular shapes. Measurements of areas shall be horizontal, and each area shall be bounded by lines vertical to the horizon.

13. Alluvial mines, not under lease at the time of the passing of this Act, and alluvial mines under lease at such time, but which shall hereafter be surrendered by their lessees, or become forfeited to the Crown, shall be laid out, so far as local peculiarities will allow, as directed in the case of quartz mines, the courses of the respective boundary lines of such mines to be decided by the Chief Commissioner of Mines; and the advance payments, or rents and royalties, shall be the same as quartz mines.

* * * * *

17. The advance sum to be paid upon any application made after the passing of this Act, for a gold mine, shall be at the rate of two dollars for each area of class *Number One*; but nothing herein contained shall prevent the repayment of royalty accruing from the leased premises, or any such advance sum paid in accordance with any former Act of this Province.

18. Applicants for leases of mining areas in private lands, may arrange, by agreement in writing, with the proprietors, for leave to enter, and for easements, and for damage to lands; and in such case the agreement shall be deposited with the Chief Commissioner, or Deputy Commissioner for the District, and the applicant shall thereupon be immediately entitled to his lease, and to enter and mine upon the area applied for.

* * * * *

29. All leases shall be for the term of twenty-one years; but the holder of any such lease may, at any time, surrender the same by notice in writing signed by him, and filed in the office of the Chief Commissioner of Mines; but nothing herein contained shall be construed to discharge him from liability in respect of any covenants in the lease, for or in

respect of any act, matter or thing, for which, at the date of such surrender, he was liable under the terms of lease.

30. Such leases may be forfeited on failure to pay the stipulated royalties, other than those arising from quartz crushed at a licensed mill, or to keep employed annually on the demised premises, the number of days' labor hereinafter specified, or to comply with any other of the provisions and stipulations in the lease contained.

* * * * *

32. There shall be employed annually on the demised premises a number of days' labor, equivalent to one hundred days for every Number One area composed therein. But any lessee, holding ten or more, but less than twenty areas, of class Number One, in any Gold District, will not be required, during the first year of his holding, to keep more than three-fourths of the number of days' labor above required to be performed per area; in like manner, if holding twenty or more, but less than thirty of such areas in the same district, he shall be required to keep employed only one-half, and if holding thirty or more only one-fourth the above required number of days' labor, during such first year. * * *

* * * * *

33. The Chief Commissioner of Mines may issue licenses to search for gold, to be called "Prospecting Licenses," which shall be subject to the rules prescribed by this Act.

34. Such Licenses may include any area not exceeding one hundred acres in extent, so as the same shall be laid off in quadrilateral and rectangular figures, and shall not in length exceed double the breadth thereof.

40. Such Licenses shall be in force for any period not exceeding three months from the date thereof.

41. All applications for prospecting licenses shall accurately define by metes and bounds, the lands applied for, and shall be accompanied by a payment at the rate of fifty cents per acre for every acre up to ten acres in extent, and twenty-five cents for every acre in addition to that extent.

* * * * *

44. The holder of a prospecting license, who shall have fulfilled all the terms and conditions thereof, shall be entitled to a renewal thereof for a second period of three months, upon like terms and conditions, except that the price of the same place shall be only half that paid on the previous application.

45. Within the period for which the license, or renewed license, is granted, the party holding the same shall be entitled to select any area or areas, not exceeding one quarter of a mile on the lode, and in breadth five hundred feet, comprised therein in form as described in this chapter, and shall be entitled to a lease of the areas selected upon the terms imposed herein.

* * * * *

47. On all leases of gold mines, and prospecting licenses to search for gold, there shall be reserved a royalty of three per cent. upon the gross amount of gold mined.

48. The discoverer of any new mine shall be entitled to a lease for twenty-one years, free from advance payment or royalty, of an area of class Number One, as prescribed by this chapter.

49. No person shall be considered the discoverer of a new quartz mine unless the place of the alleged discovery shall be distant, if on a known lode, at least three miles from the nearest known mine on the same lode, and if not on a known lode, at least one mile at

right angles from the course of the lode ; if in alluvial workings, at least two miles distant from any previously discovered mine.

* * * * *

55. Each licensed mill-owner shall separate from the yield or produce of gold of each lot or parcel of quartz, as crushed, three parts out of every hundred parts of such yield, as the portion thereto belonging, and payable to Her Majesty as royalty ; and shall pay the same in such weekly or other payments as the Chief Commissioner of Mines shall order, into the office of the Chief Commissioner of Mines or his deputy for the district, or otherwise shall pay as aforesaid, the equivalent in money for the same, at the rate of nineteen dollars and fifty cents per ounce troy for smelted gold, and eighteen dollars and fifty cents troy for unsmelted gold.

56. So soon as gold shall be obtained by amalgamation, or otherwise, from any parcel or lot of quartz crushed at any licensed mill, three parts in the hundred of such gold shall forthwith thereafter be and become the property of Her Majesty.

57. In case any licensed mill owner shall fail to pay such three parts on the hundred of gold, or money in lieu thereof, in the mode and at the time prescribed by this chapter, he shall be liable to an action at the suit of the Commissioner of Mines, as for money had and received to his use, for the value of said gold, estimated at nineteen dollars per ounce troy.

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